STATISTICAL LABORATORY

established 1933

annual report

July 1, 1987 to June 30, 1988

IOWA STATE UNIVERSITY, AMES

Contents

THE STATISTICAL LABORATORY
Iowa State University
1987-88 Annual Report

Personnel

Frederick Lorenz was on faculty improvement leave for the 1987-88 academic year. He was a visiting scholar in the departments of Sociology and Statistics at Stanford University, where he studied the sociological theory of complex organizations and methods for modeling social dynamics.

A number of changes took place during the year, primarily affecting the faculty in the area of sample survey methodology. George E. Battese, senior lecturer in the Department of Econometrics, University of New England, Australia, continued as visiting professor in the Survey Section of the Statistical Laboratory and Department of Statistics through November 1987 and returned in March 1988 for an additional three weeks.

To fill a vacancy left by Ronald Iachan, John Eltinge was appointed as instructor beginning in August and, following completion of his doctorate here, was promoted to assistant professor effective January 1, 1988.

Mark Reiser resigned effective August 21, 1987 to accept a position in the Department of Decision and Information Systems, College of Business, Arizona State University.

Stephen Haslett began a year's appointment as visiting assistant professor in the Survey Section on November 25, 1987. He is on leave from Victoria University of Wellington, New Zealand, where he has been research statistician and lecturer in the Institute of Statistics and Operations Research. Haslett received his doctorate in statistics at Victoria University in 1986.

Sherry Hsueh-Foo Lin resigned as research associate in the Survey Section to return to Taiwan with her husband in September 1987. Nancy Hasabelnaby remained in the Survey Section as research associate upon completion of her doctorate. She resigned effective May 30, 1988, in order to accompany her husband to live in Egypt. Four new professional and scientific staff appointments in the Survey Section were made in 1988: Dianne Anderson, as assistant survey projects manager, and Melissa Mabee, Janet Schultz, and Douglas Tschopp, as programmers. The increase in staff reflects larger responsibilities and workloads taken on by the Survey Section.

John Thompson resigned from the Statistical Laboratory's Statistical Numerical Analysis and Data Processing Section on August 7 to join Doane Marketing Research, in Creve Coeur, Missouri.

As part of a cooperative arrangement between Mayo Clinic and the ISU Department of Statistics, H. Samuel Wieand was appointed professor (collaborator) beginning February 1, 1988. In May he was elected a full member of the Graduate Faculty. Wieand has been a consultant in the Statistics Section, Department of Health Sciences Research, Mayo Clinic since 1985. The collaborative arrangement makes possible Wieand's supervision of graduate research in residence at Mayo Clinic, where he is responsible for design and analysis of all clinical trials done in gastrointestinal and gynecologic cancer.

Fetih Yildirim, visiting senior Fulbright research scholar, returned to his position as associate professor and chair, Department of Statistics, Middle East Technical University, Ankara, Turkey, on July 8, 1987.

Franz Hering, professor of statistics at the University of Dortmund, West Germany, visited the Statistical Laboratory and Department of Statistics for the first three weeks of September. His visit stems from previous contacts between Dortmund and ISU initiated by Noel Cressie and Paul Hinz. There is a common interest in the two statistics departments in establishing an exchange relationship.

Shie-Shien Winston Yang came in mid-May 1988 as visiting associate professor for a two-month period of research under H. A. David's Army Research Office grant project. David was his major professor for both an M.S. degree (11/74) and a doctorate (8/76) at Iowa State. Yang is on leave from the Department of Statistics, Kansas State University, with which he has been affiliated since 1979.

William Q. Meeker has been elected a member of the International Statistical Institute.

Oscar Kempthorne was elected an Honorary Fellow of the Royal Statistical Society on June 15.

Looking toward next year: Three new appointments will begin August 21, 1988. Stephen Haslett, currently on a visiting appointment, will remain in the Survey Section as assistant professor, filling the vacancy left by Mark Reiser. Debaprya Sengupta will also join the Survey Section as assistant professor, since John Eltinge is taking a position at Texas A&M. Sengupta is completing a doctorate in statistics under P. K. Sen, University of North Carolina-Chapel Hill. His earlier degrees were earned at the Indian Statistical Institute, Calcutta. John Stufken, assistant professor of statistics at the University of Georgia, has accepted a position as assistant professor in the area of experimental design and linear methods. He received a doctorate in mathematics, with statistics as a major, from the University of Illinois at Chicago in 1986 and earlier degrees from the University of Nijmegen, the Netherlands.

Jerome Sacks has been promoted to full professor/collaborator.

Kenneth J. Koehler will be on faculty improvement leave for six months beginning July 1, 1988. He plans to stay in Ames to work on a graduate-level book on statistical methods for categorical data. Stephen Vardeman was granted a faculty improvement leave that he will take spring semester 1989. His plans are to work on a new-generation engineering statistics text and do reading in the engineering control literature. The textbook writing is already underway, and existing manuscript material is being used in both Stat 105 and Stat 305.

Statistical Laboratory Staff—Fiscal Year 1987-88 under the administrative direction of:

Gordon P. Eaton, Ph.D.—president of the university

Daniel J. Zaffarano, Ph.D.—vice president for research; dean of the Graduate College

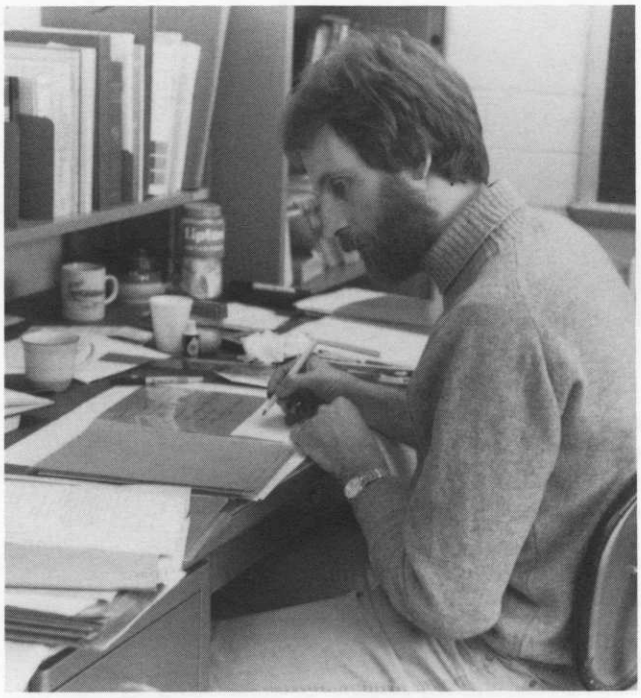
William H. Kelly, Ph.D.—dean, College of Sciences and Humanities; director, Sciences and Humanities Research Institute

Lee R. Kolmer, Ph.D.—dean, College of Agriculture; director, Iowa Agriculture and Home Economics Experiment Station (until September 30, 1987); John Pesek, Ph.D.—interim dean and director (October 1, 1987 on)

Dean L. Isaacson, Ph.D.—director, Statistical Laboratory; head, Department of Statistics; head, Statistics Department, Iowa Agriculture and Home Economics Experiment Station

Professors

Krishna B. Athreya, joint appointment with Department of Mathematics
Theodore B. Bailey, Jr.
George E. Battese, visiting
C. Philip Cox
David F. Cox
Noel A. C. Cressie
Herbert A. David, Distinguished Professor in Sciences and Humanities
Herbert T. David, joint appointment with Department of Industrial Engineering
Wayne A. Fuller, Distinguished Professor in Sciences and Humanities; faculty status also in Department of Economics
Richard A. Groeneveld
David A. Harville
Roy D. Hickman
Paul N. Hinz, faculty status also in Department of Forestry
Donald K. Hotchkiss
David V. Huntsberger, professor emeritus
Dean L. Isaacson
Oscar Kempthorne, Distinguished Professor in Sciences and Humanities
William J. Kennedy
Kenneth J. Koehler
Glen D. Meeden
William Q. Meeker, Jr.
Edward Pollak, joint appointment with Department of Genetics
Vincent A. Sposito, joint appointment with Computation Center
Robert F. Strahan, joint appointment with Department of Psychology
Norman V. Strand, professor emeritus
Stephen B. Vardeman, joint appointment with Department of Industrial Engineering
Leroy Wolins, joint appointment with Department of Psychology



Stephen Haslett, on leave from Victoria University of Wellington, New Zealand, is here for a year as visiting assistant professor. His areas of special interest are sample surveys, time series, and contingency tables.

Associate Professors

Yasuo Amemiya
Frederick O. Lorenz, joint appointment with Department of Sociology and Anthropology
Mervyn G. Marasinghe
Jerome M. Sacks, USDA collaborator
Mack C. Shelley II, joint appointment with Department of Political Science
Shaskikala Sukhatme
Fetih Yildirim, visiting, Fulbright Scholar

Assistant Professors

Harold D. Baker
John L. Eltinge
Stephen J. Haslett, visiting
Mark R. Reiser
Carl W. Roberts, joint appointment with Department of Sociology and Anthropology
W. Robert Stephenson

Temporary Assistant Professor

Paul McGovern

Resident Collaborator

Arthur D. Kuhl, USDA Soil Conservation Service, joint appointment with Department of Agronomy

Postdoctoral Research Associate

Nancy Hasabelnaby
Daniel James Schnell

Graduate Assistants

The status of graduate students often changes. Students holding appointments as graduate teaching or research assistants in statistics for part or all of the year are listed here.

Douglas Andrews
Craig Beam
Douglas Bearrood
Jonathan Biele
Linda Brands (Corning Glass scholar)
Kimberly Brown
Michael R. Carley
Alicia Carriquiry
Carl Castrogiovanni
Barbara A. Chisolm
Marie A. Coffin
Joseph Croos
Eiichiro Funo
Jooi-Tow Goh
Carol A. Gotway
Deanna L. Graf
Eric A. Grau
Martin Grondona
Joel D. Halvorson
Patrick Homble
Chong Sun Hong
Amy Hoveland
Zhaofeng Huang
Frederick Hulting
Philip Iversen (Corning Glass scholar)
Yoou-Jen Kang
Song-Ho Kim
Alice Lay
Klaus Lemke
Jyh-Shiun Lin
Tsung-Hua Thomas Lin
Ge-Shean Albert Liou
Jingyu Liu
Cynthia Long
Chi-hsien Joseph Lu
David McDonald
Frederick Medak
Carol Meeter (Corning Glass scholar)
Todd E. Melander
Jorge Morel
Terry Moy
Daniel Mundfrom
Dennis J. Murphy
Nuwan Nanayakkara
Teresa Nelson
Sarah M. Nusser
Heon Jin Park
Kathrina Payton
Peter Peterka
Anne Poggeman
Dawn E. Prins
Stephen L. Rathbun
Jill L. Roesler
Todd M. Sanger (Dow Chemical scholar)
Sahadeb Sarkar
Darrell Schroeder
David Steenhard
Gary R. Sullivan
Nae Kyung Sung
Wendy J. Swanson
James T. Symanowski
Teresa A. Takle (Procter & Gamble scholar)
Brian L. Teasley (Corning Glass scholar)
M. Bridget Tirol
Margot Tollefson
Chung-Ching Morgan Wang
Kui-Jang William Wang
Ann Weltevreden
Susan Wettstein
Susan E. White
Ching-Ching Yang
Rahmat Zakaria
Alan Zimmermann (Shell Oil scholar)

Supported Graduate Students

Abdoulaye Adam—USAID-Niger
Maria Theresa Agatep—USAID, PIET
Ahmad M. A. Al-Mahmoud—Mu-tah University, Jordan
Victor P. Brescia—National Institute of Agricultural Technology, Argentina
Mark F. Bryan—Department of Entomology, ISU
B. Keith Cranford—College of Business Administration and Graduate College
Paula Lasack Davis—Department of Entomology, ISU
Abdullah Fagih—Kingdom of Saudi Arabia
Fredolin Tangang @ Tajudin Mahmud—National University of Malaysia
Clarice Freire—CAPES, Government of Brazil
Cheng-Der Fuh—Department of Mathematics, ISU
Christian Garrigoux—Instituto Tecnologico y de Estudios Superiores de Monterrey, Mexico
Renkuan Guo—Engineering Research Institute, ISU
Karen Jensen—Department of Industrial Engineering, ISU
Shwu-Fen Liu—Department of Child Development, ISU
Sami M. A. Masoud—University of Jordan
Sueli A. Mingoti—Federal University of Minas Gerais and CAPES, Government of Brazil
Hamid R. Navvabpour—Islamic Republic of Iran
Yvon Nininahazwe—USAID-Burundi
Sellem Remadi—USAID-Tunisia
Muhamad Sabran—Government of Indonesia
Astini Salihima—MUCIA-AID-Indonesia
Muhamad Sabran—Government of Indonesia
Mary E. Saylor—Biotechnology Council, ISU (Corning Glass scholar)
Kai-One Sriplung—Center for Agricultural and Rural Development, ISU
Suharno—MUCIA-AID-Indonesia
Muhammad A. Tiro—MUCIA-AID-Indonesia
Scott Vander Wiel—Graduate College high technology program, ISU
M. Katheleen Vasconcelas—Conselho Nacional de Desenvolvimento Cientifico e Tecnologico, Brazil
Jay Ver Hoef—Department of Botany, ISU
Ibrahim S. Yansaneh—AFGRAD-USAID

Self-Supporting Graduate Students

Chao-Yin Chen
Ching-Ju Diane Chen
Shih-Neng Chen
Shou-Wei Chen
Keng-tang Chien
Jia-Chyi Chiu
Tae-Kyoung Cho
Jean B. Cormack
C. Janelle Dombek
Carol A. Francisco
Shiow-Lan Gau
Richard R. Griffiths
Geun Shik Han
Mu-Yeh Huang
Jane Johnson
Joo-Hwan Kim
Bojein Kuo
Kyung Hee Ghang Lee
Ming-Yu Lee
Mong-Hong Lee
Yung-Seop Lee
Seung-Chun Li
Chiou-Hua Lin
I-Ming Liu
Barnabas M. Misambo
Grecia Morel
Kwan Soo Park
Hussein Shamsuddin
Chii-Jyh Shyu
Steven J. Wall
Shu-Yuan Yen
Yunn-Hwu Yu

Professional and Scientific Staff

Dianne G. Anderson, research associate, Survey Section, beginning February 1, 1988
Marvin S. Beck, programming consultant, Survey Section, joint appointment with Computation Center, beginning August 1, 1987
Richard Dorsch, programming consultant, Survey Section
Mary Genalo, research associate, Survey Section
Avonelle Hefflefinger, administrative assistant
Hsueh-Foo (Sherry) Lin, research associate, Survey Section, until September 8, 1987
Melissa J. Mabee, programmer, beginning April 25, 1988

Bud Meador, supervisor, Statistical Data Processing Services
Deborah Reed-Margetan, programmer-analyst, Survey Section
Janet L. Schultz, programmer, Survey Section, beginning February 8, 1988
Kathleen Shelley, specialist, Statistical Numerical Analysis Services
Harvey Terpstra, data systems manager, Survey Section
John C. Thompson, data analyst, Statistical Numerical Analysis Services, until August 7, 1987
Douglas L. Tschopp, programmer, Survey Section, beginning May 2, 1988
Jauvanta Walker, information specialist

General Office Staff

Rose Ann Anderson, secretary
Denise Carr, secretary, July 1987
Norma Elwick, secretary
Brenda Hewitt, clerk typist, beginning November 30, 1987
Jeanette La Grange, clerk typist
Donna Nelson, clerk typist, until November 6, 1987
Janice Peters, account specialist
Denise Riker, secretary
Sharon Shephard, clerk typist
Margaret Wheelock, clerk typist
Darlene Wicks, clerk typist, Statistical Numerical Analysis and Data Processing Section
Laura Yeager, secretary, beginning May 24, 1988

Survey Section Staff

Glenda Ashley, key entry operator
Kathryn Bottorff, field interviewer
Dorothy Edwards, statistical clerk
Sharon Erbach, field interviewer
Vimlesh Gupta, key entry operator
Nancy Heathman, account clerk
Helen Nelson, secretary
Christine Olson, clerk typist
Mary Rathbone, field interviewer
Kathie Reinertson, data technician
Jasmine Seagrave, data technician
Jeanne Sorenson, statistical data processor, until April 1, 1988
Miriam Troyer, field interviewer
Susan E. Verkade, data technician
Carol West, key entry operator, until July 18, 1987
Karon White, key entry operator

Consulting and Cooperative Research

The Statistical Laboratory and the statistics department of the Iowa Agriculture and Home Economics Experiment Station provide statistical consulting and research services to the rest of the university and to local, state, and federal agencies as time and funds permit. Some of this work is supported by contracts and grants. These are supplemented by individual consulting and by summer assignments taken on by nine-month faculty.

Agriculture and Home Economics Experiment Station

Members of the statistics department of the experiment station engage in regular, continuing statistical consulting with researchers in the College of Veterinary Medicine and in the Agriculture and Home Economics Experiment Station. Leaders in the consulting group are David F. Cox, Theodore B. Bailey, Paul N. Hinz, and Donald K. Hotchkiss. Working with them this year as graduate assistants were Kui-Jang William Wang, Ann Weltevreden, and Steve Rathbun. As needed, other members of the statistical center interact with the consulting group and also consult with experiment station researchers. In addition, assistantship support for Mary Saylor was provided by the ISU Biotechnology Council for data processing and statistical consulting services to the biotechnology program.

Franz Hering, professor of statistics at Dortmund University, West Germany, sat in on a number of the experiment station statistical consulting sessions while visiting here in September 1987.

An era in statistical computing closed in 1988, but its end was marked only by a brief announcement in the monthly newsletter of the ISU Computation Center. As the new fiscal year begins, this university no longer maintains equipment capable of reading punched cards. The final elimination of the 80-column card has been accomplished. It signaled what had already occurred here and elsewhere and was probably unnoticed by most. Those cards were once at the heart of statistical data processing, and units like the one once run by Mary Clem in this department were central to data analysis. The evolution of modern computing churns along relentlessly and does not leave many clear landmarks. The end of cards and all their associated equipment seems to demand at least a nod.

Consulting services were once totally card-oriented. A consultant usually had a tray of programs on cards that were the only means of turning the data, that arrived on cards, into summaries and statistics. Job control cards were part of the business as key punches and card jams were part of the frustrations. It is all gone, replaced by keyboards, video monitors, and floppy disks.

Besides providing the older generation with a heavy load of nostalgia, is there any message in this milestone? Good perspective in a field changing as fast as this one is difficult to obtain, but certain things seem to be evident. Research workers had no choice but to come to the central data processing machinery in the card-oriented environment, and usually that meant some contact with statisticians. Today statistical software resides on almost all personal computers, and it is often in a simply used menu-driven form. It can be used without much understanding. The system may give enough direction that the contact with a statistician is unnecessary. Few people miss the cards. Many current researchers do not even realize that color monitors, spread sheets, and 9600 BAUD rates were not always part of the scene.

The Iowa Agriculture and Home Economics Experiment Station continues to upgrade the hardware and software used for statistical consulting. This year saw the addition of two Zenith Z-386 personal computers with color monitors and interconnections with the main university computer. The latest version of PC-SAS is installed, as are other packages and locally written routines. The university's electronic mail provides convenient communication between users and consultant without office visits. Laser printers are on order. Services to produce color slides from graphics software are usable. Lest we forget, about the only thing that has not changed is the need for good sense of the kind evident in the writings of George Snedecor and Bill Cochran.

As the great drought of 1988 unfolded on the prairies, interest in weather data and prediction intensified. Harry Vaughan from the Department of Agronomy consulted with D. F. Cox on many aspects of meteorological data. While theories of cycles and periodicity in rainfall abound, Vaughan finds them difficult to confirm in the weather records and believes that randomness in rainfall amounts is more important than most forecasters like to admit.

As most universities have, Iowa State has made a major commitment to the general field of biotechnology. The Biotechnology Council is supporting statistical consulting through an assistantship. Many research workers in this area have come up through the field of biochemistry, which has not been a strong user of statistical methods. Some of those researchers are utilizing field studies for new materials but are unfamiliar with the rudiments of agronomic statistical field design. The challenges for statistical consultants are real. A new generation largely unfamiliar with statistical methods is in charge of research and needs education.

Ted Bailey's extensive use of his new Zenith (IBM-compatible) personal computer in the interactive mode in consulting activities with experiment station researchers has resulted in efficiencies relative to data analysis, including graphic analysis. It enables him to interface easily with the mainframe computer in the Computation Center and to maintain and organize his consulting files effectively. He can transfer a client's data from the mainframe and then sit down with the client to perform analyses and discuss results and interpretations. Through such participatory demonstrations, valuable incidental teaching functions are accomplished as part of the consulting.

Bailey's consulting, as well as that of others in the consulting group, reflects the increase in research in molecular biology and biotechnology on campus. For example, a microbiology graduate student was investigating the developmental stages of viral particles in seeds in an effort to gain an understanding of the nature of disease resistance in soybean seeds. Bailey advised on the required sample size needed for determining whether seed lots were contaminated with infected seeds.

He held extensive discussions with an agronomy graduate student on research bearing on the relation of isozyme genotypes to quantitative traits of soybeans. The student was using biotechnology techniques that would be of great interest if they proved successful in identifying superior quantitative characters. This study resulted in highly structured data, including both crossed and nested factors, and consequently many problems in the analyses.

Ted Bailey is also concerned with how basic quantitative genetic models can utilize the extra information now being obtained through the use of biotechnology in the improvement of plants and animals.

A response surface design was recommended by D. F. Cox in an experiment to investigate the effects of using dried beef plasma as a substitute for egg whites in cake recipes. K. J. Wang and Paul Hinz helped with the analysis of the data.

Paul Hinz consulted on several projects from the fisheries section of the Department of Animal Ecology. One project was designed to determine the abundance of larval fish along developed and undeveloped sections of the shoreline of Spirit Lake, Iowa. The information will be used to decide if protection of undeveloped shoreline would be beneficial to the productivity of the lake's fishery. Another research project was initiated to determine if walleyes could be successfully reared in tanks. An experimental design was set up to investigate the effects of feed type and stocking density on rate of growth, mortality, and cannibalism.

Steve Rathbun and Sheri Cutler analyzed data from an experiment on the mating behavior of katydids.

Data on the physiological characteristics of soybean seedlings was analyzed by Ann Weltevreden. Very detailed and tedious measurements had been made on the numbers of cells and dimension in cross sections of the hypocotyls of seeds germinated at various temperatures. Weltevreden's analysis provided a basis for deciding on the number of cross sections and the number of replicate measurements to be used in future research.

Donald Hotchkiss consulted with several faculty in the Department of Veterinary Physiology and Pharmacology. In one study, help was requested in the analysis of several physiological measures on greyhounds fed high and low levels of meat in their diet for a 20-week period. In another study, assistance was given in the design and analysis procedures for a study to measure contamination of broiler birds during the scalding (feather removal) stage of processing.

Hotchkiss worked with researchers in the Department of Food and Nutrition in the analysis of data on human subjects that were given different diets during consecutive experimental periods. A design to allow for carryover (residual) effects was utilized to make adjustments for diets consumed during the preceding experimental period.

The College of Family and Consumer Sciences obtained support from the consulting section in the preparation of a request for the establishment of a federal Human Nutrition Research Center at Iowa State. The center is proposed for the study of food

selection for nutritional assurance and is intended to connect research in food production with the needs of consumers.

Edward Pollak provided mathematical assistance to a graduate student researcher in the Department of Animal Science. The student's objectives were to classify individuals in samples from two breeds of swine with respect to restriction fragment length markers and then try to associate variation in such genetic markers with variation in performance traits.

Statistical Numerical Analysis and Data Processing Section

The Statistical Numerical Analysis and Data Processing Section of the Statistical Laboratory provides statistical computer programming and data processing support for research projects conducted both on and off campus. Activities of the section include developing software for special applications, designing and installing databases for general use, maintaining general-purpose software systems, and consulting on problems related to scientific applications of digital computers. Teaching and research activities for the section are led by William J. Kennedy, Vincent Sposito, and Mervyn Marasinghe, and are reported elsewhere in this annual report.

The continuing proliferation of personal-type computers and personal computer software produced another substantial increase in the general consulting and service workload of the section this year. Questions asked by consultees often dealt with the areas of computer and statistical graphics, intercomputer applications, and database management using personal computers, but also many people brought in the more usual kinds of problems encountered while using various kinds of numerical applications software.

Section personnel are now more heavily and directly involved with computer hardware. New computing equipment acquired by the Department of Statistics, the Statistical Laboratory, or the experiment station statistics department is processed by the section. This involves checking the equipment, installing software, and implementing interfaces with other equipment if applicable. Then the recipient of new equipment is given an orientation to its use, when needed. Section personnel are also called upon to coordinate maintenance and repair operations for the computer-related hardware currently in-house. Finally, section staff are normally consulted regarding specification details when orders for equipment or software are prepared. Much of the kind of work mentioned above has only recently become a part of the section's activities, and it certainly represents a major addition.

The Statistical Data Processing Group, supervised by Bud Meador, included research assistants Dave Steenhard, Phil Iverson, Klaus Lemke, and, briefly at the beginning of the year, both Bridget Tirol-Zimmerman and data analyst John Thompson. The Statistical Numerical Analysis Group, supervised by Kathleen Shelley, included research assistants Mike Carley, Albert Liou, and Morgan Wang. Specific activities included the following during the year.

John Thompson wrote and installed PC software to support a laser printer and a pin plotter. In the process, the famous Cowboy Hat graph, as well as the Iowa County Map plot, became familiar graph products to even a casual observer. Following Thompson's resignation to join a market research firm in Missouri, Dave Steenhard took over his PC/SAS responsibilities and Phil Iverson assumed continuing responsibility for the database system developed for Iowa's State Forest Nursery. Other duties associated with the vacant position, such as statistical software consulting and the providing of technical assistance, were shared among the members of the group.

Klaus Lemke and Dave Steenhard handled many of the recurring projects from crop experimentation, plant breeding, student scheduling, etc., for clients making use of the university's NAS 9160 research computer. The entire group contributed to the initial test and setup of the Statistical Laboratory's 386-based personal computers.

Installation of statistical computing software on PCs in other departments is a growing effort of the section. Most installations were done on or near the ISU campus. However, Alicia Carriquiry was sent to Peru for two weeks in April as a section representative to install SAS microcomputer software and to provide training and instruction in its use and applications *en espanol*. This was part of an ISU-AID project directed by Ray Beneke, Department of Economics, and sponsored by the Mid-America International Agriculture Consortium. It required a person such as Carriquiry who had a strong statistical computing background and could effectively communicate with research workers and faculty at the National Agrarian University, La Molina, Peru.

The impact of personal computers is evident in two additional tasks undertaken by the Statistical Numerical Analysis and Data Processing Section. First, a project for the ISU Center for Industrial Research and Service (CIRAS) is undergoing a mainframe-to-PC conversion. This involves dBASE software for maintenance of a database and PC/SAS software for data analysis and report writing. Second, a PC data communication program is being developed for use on the university's telephone and data communication equipment. This project supports PC-to-PC or station-to-station data transmission for a number of applications.

Presentation graphics comprised much of the work done by the Statistical Numerical Analysis Group during the year. Morgan Wang and Kathleen Shelley developed a short course entitled "Introduction to SASGRAPH." It was presented in the university Computation Center to enable SAS users to generate their own graphs on the mainframe laser printer and colored slides by means of the QCR utility. It was also given for Statistical Laboratory members.

Albert Liou and Morgan Wang produced a computer generated map of Fragipan soil types for all counties in the United States for the Survey Section. Colored transparencies were produced for Ted Bailey, Mack Shelley, and Bill Kennedy for various professional presentations. Wang produced a colored slide show for use in presenting results of an experiment conducted by a faculty member in the Department of Textiles and Clothing. Wang also wrote SAS programs to analyze data from the experiment, which was designed by David Cox. This experiment provided data to analyze various laundry treatments used in attempting to reduce chemical residue in farmers' clothing. With the advent of SASGRAPH in PC/SAS, section personnel have been producing some graphs solely on PCs.

Mike Carley has written PC/SAS programs to enable a researcher in weed science to produce randomized labels for herbicide application. Carley also is developing report writing programs on the PC for him. When data collection is finished, the analysis will be totally run on a personal computer with output to the researcher's Laserjet printer.

Data from the university's SPEAK/TEACH programs are being analyzed again, by Carley and Kenneth J. Koehler, now that two years of data are available for comparison. This work is being done for members of the Department of English and the Office of the Dean of the Graduate College to ascertain the effectiveness of those programs in evaluating nonnative teaching assistants' instructional performance in the classroom. Carley has used both the mainframe and PC/SAS to analyze the data and has produced many graphs to accompany the analysis.

Work continued for the Iowa Small Business Development Centers (SBDC). Their system for working directly on their PCs across the state of Iowa was vastly simplified by the use of Carbon Copy Plus communications software. With two PCs connected via modems, the screen of the host computer is displayed on the operating PC, thus enabling execution and testing of software from a remote location. Carley and Kathleen Shelley have been involved with installing and testing this software for the twelve subcenters in Iowa. Albert Liou, using dBaseIII Plus software, developed another section of their database entry for client-consultant assignments. Tutorial help was given to a staff member at the SBDC administration center to enable her to write her own PC/SAS report programs to analyze the client data base.

Some projects mainly involved analysis of data from surveys for other departments on campus. These included a survey to assess job satisfaction of residence hall workers, a survey tracking attitudes and abilities of company truck drivers, and a survey concerning adoption of wheat production in Saudi Arabia.

Ken Koehler assisted with an observational study of types of learning activities in classrooms for mentally disabled students. Morgan Wang and Kathleen Shelley worked on an analysis for tracking student enrollment patterns at Grand View College.

Survey Section

The Survey Section of the Statistical Laboratory, under the direction of Roy D. Hickman, provides consultation and direct operational assistance to research workers in sample design and the planning and execution of sample surveys and censuses. Section staff engage in all areas pertaining to the operational conduct of surveys. Professional staff members also conduct research and teach courses in the areas of sampling, survey design, and statistical methods.

The section is currently involved in three longitudinal studies of families in rural Iowa for researchers in the departments of Family Environment, Sociology and Anthropology, and Child Development. All three projects will attempt to assess the impact of economic stress on rural families.

The first project, supported by the National Institute of Drug and Alcohol Abuse, is a two-wave panel study of 200 two-parent rural Iowa families. The major objectives of this study are to investigate the impact of economic stress on the quality and stability of marital and child-parent relationships and to assess the relationship between economic stress and the emotional and behavioral functioning of parents and adolescents. Parents and two children in each of the families will be interviewed and their behavior and interactions videotaped once a year for two years. The Statistical Laboratory conducted a pilot study of 75 families during the past spring to refine questionnaires and study methodology.

In a second study, supported by the National Institute of Mental Health, a panel of 500 Iowa families will be interviewed annually for three years to investigate variations in rural family resilience to economic stress. This study will seek to replicate findings of earlier work on protective and risk factors in depression-era families experiencing economic loss. The panel includes two-parent rural families with a seventh-grade adolescent and a sibling within three years of age of the seventh-grader. Survey Section staff are assisting with methodology and design of forms and will recruit and conduct personal interviews with the families each year, as well as being responsible for data management and processing over the three years.

Objectives of the third project are to investigate how economic hardship and transitions from elementary to secondary school impact children's patterns of coping and adjustment during the early and middle adolescent years. Over a three-year period, 360 two-parent families, each with a sixth- and an eighth-grade child, will be interviewed. The resulting data will be combined with the children's academic performance records as obtained from the public schools. Survey Section personnel will complete all interviews and code and enter the data from each of the four family members involved. This project is also funded by the National Institute of Mental Health.

A statewide area sample of housing units was selected for a home energy study conducted cooperatively with university extension specialists. To be eligible for the study, a housing unit had to be a single-family, detached unit occupied by its owner for

at least the preceding year. Also the occupants had to agree to make their utility records available to the researchers. The survey was designed to assess residents' attitudes toward energy, indoor air quality, and health-related topics, to determine the type and severity of indoor moisture problems, and to characterize the energy efficiency of Iowa homes. Section staff assisted with methodology and forms development, conducted interviews with 343 home owners, and took measurements of temperature, moisture, square footage, and the presence of radon in the home. Data are currently being coded and processed preparatory to analysis.

Survey Section staff cooperated with a faculty member from the Department of Family Environment on preliminary work for a multi-state cooperative study of persons who have income-generating operations in their homes. Consultatory activities included discussion of sample sizes, sample design, data gathering techniques, questionnaire design, and costs of various options. Because information on the incidence of households containing home-based workers was inconclusive, a pilot study was designed to estimate the frequency of such households separately for urban and rural subregions within each of eight states. Telephone interviews with 1,120 households were completed by Survey Section staff. The results will be used in planning the primary survey design and setting sampling rates. In addition, information from the pilot study will be used by the researchers in establishing the criteria for identifying a home-based worker for purposes of this study, which will examine the management, productivity, and stability of at-home income generation.

Telephone interviews were conducted with a sample of Iowa craftspersons, half of whom were designated as financially successful and the other half as unsuccessful. The study was designed to assess craftspersons' marketing techniques, product lines, and business skills, as well as perceptions of their success as a business person and artisan. Faculty members from the departments of Textiles and Clothing and Art and Design, and affiliated extension specialists hope to use the results to assist Iowa craftspeople in marketing their products.

A study to develop comparative profiles of males and females who have been investigated for child sexual abuse is being completed, assisted by Survey Section personnel. The profiles are expected to identify factors that may contribute to such offenses, as well as information that can be used to design successful treatment and rehabilitation programs. A Department of Family Environment researcher is currently analyzing data from 100 subjects interviewed by section staff.

For the fourth year, personnel from the Survey Section assisted in a pilot study to measure the effects of deer depredation in corn and soybean fields near a state park having a large population of deer. The study is being carried out by the Iowa Department of Natural Resources. Each year the basic sample design is modified to adjust for changes in the numbers and locations of the fields.

The biennial school census of households for the Ames Community School District was completed by the Survey Section during the spring. The census is conducted to help estimate projected enrollment from the current pre-school population in the community.

The Survey Section selected a statewide sample of school superintendents and teachers for the ISU Research Institute for Studies in Education (RISE) for a needs assessment mail survey. Five groups were defined and sampled separately: superintendents, elementary teachers, secondary mathematics and science teachers, secondary foreign language teachers, and all other secondary teachers. Systematic samples were selected from material supplied by the State Department of Education.

A sample of Iowa counties was selected for a student in agricultural economics investigating agricultural land movement associated with the financial stress of the 1980s. The student will be gathering data from the records of land transfers on file at the county courthouses.

During his time at ISU, Stephen Haslett continued to provide assistance to the Institute of Criminology, Victoria University of Wellington, New Zealand, on the analysis of a survey on community attitudes toward crime and policing in Wellington. This study, the first in a series, is designed to monitor both changing community attitudes toward particular crimes and support for different forms of policing.

Members of the Survey Section provided consultative services on sampling, data collection, questionnaire design, and data coding/entry to colleagues and students from various disciplines. Study topics included adjustments of women to retirement, changing gender roles in women 50 years of age and older, social networks for the elderly, day-care center administration and licensing, needs of poverty-level Iowa families, demographic characteristics of Iowans receiving energy assistance, attitudes of Iowans toward public education, fairness of long distance telephone toll charges in southwest Iowa, knowledge of rural males about cardiovascular risks, coccidiosis in swine, nitrogen level in corn fields, faculty attitudes toward selected library services, attitudes of dormitory residents toward changes in university policies on student parties, and job search strategies of ISU graduate students.

Mary Genalo traveled to Washington, D.C., December 4-7 to discuss design and data collection procedures for a study of sexual abusers of children; she returned to the Capitol on May 13-16 to report on a pilot study of home-based workers.

Wayne Fuller and Roy Hickman traveled to the National Center for Animal Health Information Systems on April 25-26 in Fort Collins, Colorado, to meet with Animal and Plant Health Inspection Services (USDA) personnel to discuss the planning and implementation of a national animal health study. A cooperative project with the National Agricultural Statistics Service and the Statistical Laboratory is being considered.

Industry and Engineering Sciences

Statistical consultation with engineering and physical science faculty and graduate students is supported by the Engineering Research Institute, the Statistical Laboratory, and joint faculty appointments in statistics and industrial engineering. Statistical consulting with industry is provided through a program of collaborative and affiliate research and consulting.

For the second year Donald Hotchkiss presented sessions on basic statistics and statistical aspects of process control at a Quality Assurance Short Course sponsored by the American Meat Institute and held in November 1987 at Iowa State University.

Industrial Consulting

William Q. Meeker, Jr., continued to serve as a consultant to the AT&T Bell Laboratories Quality Assurance Center, Holmdel, New Jersey, throughout the year. During the summer of 1987 he spent six weeks visiting the center, where he consulted with the developers of a software package for reliability data analysis and did research on regression diagnostics for censored data and on applying ideas from the Artificial Intelligence field to the analysis of reliability data. Meeker returned to Bell Laboratories for three weeks in June 1988 to continue this work.

Bandag, Inc., in Muscatine, Iowa, is the most recent company to become a member of the ISU Industry/University Affiliate Program for Productivity, Quality, and Reliability. This program is a joint endeavor of the departments of Statistics and Industrial Engineering with support from affiliate companies.

The principal activities in the affiliate program for the fiscal year 1987-88 consisted of continued development and publication of software for engineering statistics, dissertation research in optimal stochastic control carried out by Karen Jensen, and an applications research project carried out in cooperation with John Deere. Other work was done in the areas of life data analysis and engineering experimentation with Bandag, Inc., and in the application of variance components analysis to the testing of pressure relief valves with Sundstrand-Sauer.

With research assistantship support from affiliate program funds, Pete Cyr (an industrial engineering graduate student) and Karen Jensen continued to work on small interactive statistical computer programs to support engineering applications. As somewhat novel programs are developed, they are being put into the public domain via submission for publication. One appeared in the *Journal of Quality Control* this fiscal year (see the abstract of Crowder, Jensen, Stephenson, and Vardeman on p. 27), another will appear in July 1988 in the same journal, and a third is presently being written up.

Jensen continues her dissertation work on stochastic control theory having potential application to computer-controlled machine tools. Her research explicitly incorporates the features of measurement error, adjustment error, and deterministic drift potentially modeling tool wear effects.

Pete Cyr has worked with a division of John Deere in Horison, Wisconsin, to implement and test one of Jensen's machine adjustment algorithms against other possible control routines for a bar lathe. This work will both form the basis for Cyr's M.S. thesis and provide John Deere with useful information on alternative ways of operating their machinery.

Stephen Vardeman, Roger Berger (Department of Industrial Engineering), Karen Jensen, and W. Robert Stephenson made a site visit to Bandag, Inc., in September. Stephenson and Bill Meeker have consulted with Bandag on a retread warranty problem involving the analysis of life data. It appears that Meeker's work on limited failure populations will form the basis of Bandag's analysis of their problem. ISU Department of Statistics personnel have also provided advice to Bandag on the teaching of in-house courses in engineering experimental design.

Vardeman and Jensen provided consulting assistance to Sundstrand-Sauer in Ames on the analysis of some pressure relief valve test data. Simple plotting techniques and variance component estimation were employed. Also, in the past year, Eiichiro Funo has helped Sundstrand-Sauer with the translation of Japanese technical material into English.

"Taguchi is the *new guru* because he tells us things that we all know but have not incorporated into our thinking to an extent that is adequate at the present time . . . The ideas that Taguchi exposits have been 'around' for, by now, more than 25 years. The basic underlying ideas have been around, *explicitly,* for some 40 years. Finney wrote in 1948. My own first paper in the area was 1947. And so on and so on. . . ."

". . . I have used the phrase 'buzz word.' But to dismiss the Taguchi phenomen with just this phrase is to miss the real phenomenon for its superficial appearance. We in statistics . . . failed to get across the overall message to engineers. Obviously, Taguchi succeeded where we failed. . . ."

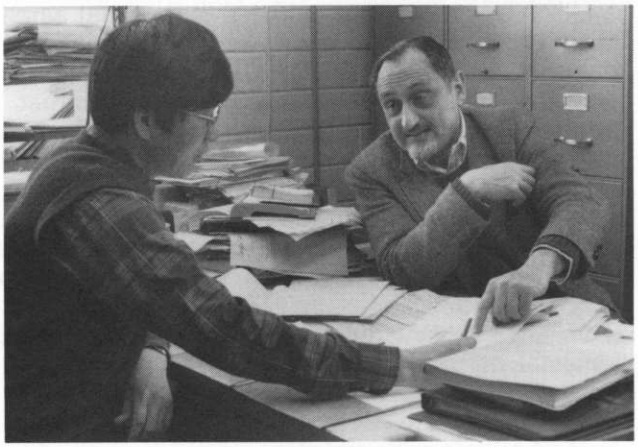
—Oscar Kempthorne, from "Statistical Design of Experiments—Historical Overview," at an ISU Conference on Sources of Improvement of Quality and Productivity, November 1986

The Second Annual Affiliate Program Luncheon meeting was held on November 20 prior to a two-day Conference on Improving Quality and Productivity at Various Levels, with affiliate company representatives and ISU personnel attending. The luncheon was followed by a short financial and activity report by Steve Vardeman, a technical presentation by Karen Jensen and Pete Cyr, some comments on recent trends in quality and productivity by noted consultant Bill Golomski, and a general discussion on the possibility of establishing an ISU Productivity, Quality, and Reliability Center led by Roger Berger.

A guest lecture given to an ISU industrial engineering class by Stephenson on "Experimental design and quality improvement: The Taguchi phenomenon" was videotaped for use by the affiliate program.

Engineering Research Institute

Statistical consulting advice and assistance were provided to over 30 projects of the Engineering Research Institute by Herbert T. David, Stephen Vardeman, and Renkuan Guo, whose assistantship was supported by the institute. The majority of projects involved researchers in civil engineering, chemical engineering, and industrial engineering.



Renkuan Guo (L) and H. T. David review statistical aspects of an engineering research consulting problem.

Topics dealt with during consulting in civil engineering included the following: design of a split-split plot experiment to detect chemical contamination; Weibull censored regression for a water resource project testing ground water contamination; a transportation simulation model; smoothing techniques utilizing multiquadric kernels and semivariograms in geodesy and photogrammetry; and stochastic stress-strength comparisons.

Projects in chemical engineering involved exploratory data analysis, nonlinear model fitting and evaluation, and predictor selection, for example in the prediction of coal hydrophobicity. Industrial engineering researchers brought up such problems as formulating scheduling optimization criteria for dynamic time-dependent scheduling; quality evaluation for a service unit; nonparametric methods; model fitting with sparse data; and stepwise regression.

Consulting topics involving other departments ranged from Hankel matrices, asymptotic approximations, and the use of Fortran programs in statistical computing to evaluation of the covariance structure of geostatistical data.

Physical Sciences

Stephen Vardeman advised on Bayesian analysis in an inverse scattering problem for a nondestructive evaluation project of the Ames Laboratory of the U.S. Department of Energy. Another Ames Laboratory consulting project involved constrained nonlinear least squares in a heat capacity problem. A physicist's research on radon led to consultation on a household survey of radon gas levels and multiple regression analysis.

Social Sciences and Humanities

Kenneth J. Koehler is a coinvestigator with Department of Psychology members Harry Lando and Paul McGovern on a three-year grant project supported by the National Institute on Drug Abuse through June 1988. He is serving as a statistical consultant for the social learning analysis of smoking cessation clinics. (Also see p. 17.)

Koehler worked with two faculty in English on the analysis of data to identify factors related to English writing proficiency of international students for whom English is not the native language. He also served as a statistical consultant for the evaluation of a program designed to evaluate and improve the performance of international teaching assistants.

During summer 1987 Frederick Lorenz worked with colleagues in family environment and sociology on methodological problems in the measurement and analysis of rural economic stress and its impact on families, especially families that have lost their farms. The work was done in preparation of a grant proposal submitted to the National Institutes of Mental Health. (See p. 8.)

Carl Roberts is acting as a consultant with IRIS Computer Systems, Inc., in the development of content analysis software.

Mack Shelley II consulted with Iowa State University faculty and students in the departments of Community and Regional Planning; Political Science; Family Environment; Industrial Engineering; Journalism and Mass Communication; Sociology; Economics; Family and Consumer Sciences Education; and the Office of International Educational Services.

These projects included the analysis of survey data on the following topics: the Logan Rehabilitation-Redevelopment Program in Des Moines, life stressors, time use in the United States, the role of geographic proximity in the relationships between aging parents and adult children, service delivery alternatives in public transit, customer satisfaction with accommodations in the ISU Memorial Union, audiences attending performances at ISU's C. Y. Stephens Auditorium, financial management practices (using data collected in Marshalltown, Iowa), and personal debt problems in Scotland. The projects also included the analysis of survey data on inter-organizational relations, employee and management attitudes toward restaurant tipping, the professional integration of international women, food service in Iowa hospitals, housing conditions, and the 1984 U.S. presidential election. Nonsurvey work included projects dealing with community development block grants in Iowa and U.S. defense expenditures.

Shelley also consulted with the Center for Transportation of the Council of State Governments, in

Lexington, Kentucky, on a survey dealing with the privatization of transportation services.

Robert Strahan visited Georgia State University in Atlanta February 4-7 to supervise testing for an ISU contractual investigation headed by James Ratcliff, professor of professional studies in education. The contract is funded by the U.S. Department of Education. The main aim of the project is to determine those courses or patterns of courses most associated with an increase in generalized learning skills, as measured by residualized Graduate Record Examination scores. Other schools participating in the three-year project are Mills State College, Stanford University, Evergreen College, and Ithaca College.

Strahan also provided statistical consulting for a study of age differences in Chinese (PRC) children's self-concept; a job satisfaction survey of Honeywell International managers; a follow-up survey of drug and alcohol use by ISU students; a survey of the extent to which school psychologists' recommendations are acted on, and factors relevant to such action; an evaluation of the effectiveness of a summer orientation program for academically-at-risk students; a dose-time-level experiment on the analgesic effects of a morphine-like drug on chicks; and an experiment testing the relative efficiency of a new technique for automobile air conditioning.

Leroy Wolins worked with a State Board of Regents committee on using psychological tests to select merit employees.

Other Consulting/Cooperation

For the last three years Noel Cressie has been doing collaborative research with faculty of the ISU Veterinary Diagnostic Laboratory on analyzing the time distributions and time sequences of behavioral acts. Bootstrap standard errors were used to determine differences in pattern from treated and controlled animals, with point-pattern data from studies of rats exposed to phenytoin and nitrous oxide.

Cressie has been collaborating with R. J. Carroll (Texas A&M University) and D. Ruppert (Cornell University) on ways to estimate efficiently the parameters of the Michaelis-Menten model seen in biological and biochemical situations. They have developed a transformation-weighting model that synthesizes most of the previous estimation methods into maximum likelihood estimators for special cases of the model.

During the period he has been at ISU, Stephen Haslett has worked on a number of consulting and cooperative research projects with colleagues in New Zealand. A draft for a joint paper with T. C. Brewes on the evaluation of perpetual leases of land has been prepared. Also work continued on an algorithm for degrees of freedom in contingency tables containing sampling zeros; this general study has direct application to the collaborative research currently being undertaken with Jane Kroger of the Department of Education, Victoria University, on Ego Identity Status change in midlife adults.

Kenneth J. Koehler worked with a visiting scientist from the Soybean Research Institute, Nanjing University, People's Republic of China, and a member of the ISU departments of Agronomy and Genetics in developing multivariability indices to be used in the analysis of plant breeding data.

In addition, Koehler assisted in the development of grant proposals and the design and analyses of studies for a wide range of research projects at ISU. These involved graduate students and faculty from the departments of Animal Ecology, Agricultural Engineering, Animal Science, Professional Studies, Textiles and Clothing, Economics, and Psychology.

Statistical consulting services were provided to the Office of Transportation Research, Iowa Department of Transportation, under a contractual agreement between IDOT and Iowa State University. Under Kenneth J. Koehler's guidance, Susan White served as statistical consultant from August 1 through December 15. She worked primarily on a statistical sensitivity analysis of the factors used to evaluate the condition of each segment of the Interstate highway system in Iowa. She also worked on a research project on the evaluation of the effects of temperature on a state-of-the-art piezo electric weigh-in-motion device. Jae McKeown continued statistical consultation with IDOT during spring semester.

Statistical guidance and improved statistical methodology are provided to research staff of the Agricultural Research Service, USDA, under a five-year contractual agreement between the USDA-ARS and the Department of Statistics. The project leader is resident collaborator Jerome Sacks. Much of the work relates to investigations at the National Animal Disease Center.

During the year, research assistants Chong Sun Hong and James Symanowski continued to work under Sacks' guidance to give consultative support. Also creative components for M.S. degrees in statistics were developed by Jane Johnson and Susan White out of consulting problems. One concerned the analysis of experimental data on post weaning diarrhea in piglets; the other, evaluation of a mathematical model that predicts the number of working days available for planting and harvesting.

Jerome Sacks served as USDA-ARS Midwest Area Statistician for research staff in Iowa, Missouri, and Minnesota. As part of this work he made site visits in Minnesota on November 15-16 and May 9-11 to consult with research staff at the Soil Research Laboratory, Morris; the Potato Research Laboratory, East Grand Forks; and the Agronomy and Plant Science Laboratory, St. Paul. Sacks is regularly involved with the planning and designing of experiments and data analyses. Problems have ranged from the statistical analysis of data on the effects of dietary aflatoxins in turkeys to the estimation of molecular weights of viral proteins.

Current Research

This section summarizes individual research and research projects supported by grants or contractual agreements. Within the university, funds were provided for research by the budgets of the Statistical Laboratory, the Iowa Agriculture and Home Economics Experiment Station (AES), the Sciences and Humanities Research Institute, and the Engineering Research Institute.

AES Project 890

Oscar Kempthorne has worked toward a more complete understanding of the nature of analysis of variance. He continued his study of the utility and proper use of ideas of randomization in intervention experiments. The use of traditional randomization procedures may be questioned in particular situations of opinion or knowledge about the experimental material. It is thought that significance tests and associated statistical intervals often should be based on the randomization process actually used and related randomization tests, rather than on analysis of variance ideas. If traditional randomization is done, then analysis via Gauss-Markov normal linear models may well be appropriate. However, with the use of various types of restricted randomization, such analyses have very doubtful validity.

AES Project 2588

Edward Pollak did research on mathematical and statistical genetics under Project 2588 of the Iowa Agriculture and Home Economics Experiment Station. Work continued on the theory of fertility selection and the approximate calculation of survival probabilities in populations with several types of individuals.

It was found that, if there is selection only for fertility in a population with two alleles at one locus, and genotype frequencies are initially near those at which there is both a stable equilibrium and maximization of the mean fertility, then the mean fertility ϕ_t at time t is a nondecreasing function of t as t becomes large.

Probabilities of survival were calculated for a slightly advantageous mutant gene that initially appears in one individual in a finite age-structured population, whether the locus under consideration is autosomal or sex-linked. The population was assumed to have the same age-structure and sex ratio at times 0,1,2,···. It was found that the probability of survival of a mutant allele A is proportional to the effective population size and the average selective advantage, over sexes, of individuals with one copy of A in their genotype. It is also inversely proportional to the generation interval, which is the average of the ages of parents when the offspring are born.

National Resource Inventories and Soils Data Bases

The Survey Section continued cooperative research with the Soil Conservation Service, U.S. Department of Agriculture. This joint work has been an important part of the work of the Statistical Laboratory since 1956. The current project is supported through Project 2739 of the Iowa Agriculture and Home Economics Experiment Station and is directed by Roy D. Hickman.

An important area of the cooperative work is the maintenance, updating, and continuing development of the soil interpretations database of soil series in the United States. Harvey Terpstra directs this work, assisted by Deborah Reed-Margetan, Jan Seagrave, Fred Medak, Janet Schultz, and Douglas Tschopp.

With the addition of 1,500 new records, the database now contains nearly 29,500 records, occupying 215 million bytes of storage. Approximately 11,000 records were revised this year. With the addition of over 200 survey areas, the soil map unit file now contains information for 2,560 soil surveys. Sizable revisions were performed on this file during the year. The soil series classification file, which is stored in the SPIRES database management system, is being heavily used. This database is organized to allow SCS personnel to query and update the data interactively from remote sites.

Installation of the SCS official soil series description was recently completed. This large file contains the official description of all soil series in the United States. The database contains mostly textual information that is stored in a direct-access VSAM data set, plus some heading information that is stored in the soil classification file using SPIRES. Programs were developed to allow the descriptions to be retrieved and updated from remote sites. This file was transferred to the Statistical Laboratory as part of a plan to centralize soils data maintained by SCS. For the first time, similar data elements in three different SCS data files can be automatically coordinated to avoid inconsistencies. Fred Medak has led the programming work on this project.

Development is underway to begin using the ORACLE relational database management system to store the SCS soil map unit file at the ISU Computation Center. Once this phase is in production, work will be initiated to integrate all of the SCS soils databases maintained by the Survey Section, using ORACLE as the management tool. ORACLE will make it possible for SCS staff to interactively query their database and will provide a more productive and flexible environment for program development. Deborah Reed-Margetan has led the work on this project.

The SCS conducts a National Resources Inventory (NRI) of the country's soil and water-related

resources every five years. During the past year, data for the 1987 NRI have been collected by SCS state personnel and sent to the Survey Section for processing. The 1987 NRI is the first inventory specifically designed to estimate changes in land use and cover that have occurred during the past five years. Because of the change aspect, the field work consisted of recording current information as well as verifying and updating data from the 1982 NRI.

Two main types of data are associated with the 1987 National Resources Inventory: county base data and Primary Sampling Unit (PSU) data. County base data provide total acreages for each county in the U.S. for categories such as land area, water area, federal land, roads, and railroads. The PSUs are a set of randomly sampled locations throughout the U.S. The PSU data provide information, for example, on soil characteristics, land use, and soil erosion. The 1987 NRI sample is a stratified sample of about 100,000 PSUs from the 330,000 PSUs used in the 1982 NRI. The sample was supplemented with 2,500 new PSUs selected in swiftly urbanizing areas. The supplemental sample will be used to estimate more precisely the quantity of agricultural land being converted to urban use.

County base data were entered on preprinted worksheets provided by the Survey Section, and returned to ISU for data entry and computer editing. Tables will be produced showing the acreage changes from 1982 to 1987.

SCS field personnel entered the PSU data on AT&T 3B2 minicomputer systems located in each state SCS office, and transmitted the data to the Statistical Laboratory via floppy disks or cassette tapes. The data, consisting of both 1987 and 1982 information, was uploaded to the ISU mainframe computer for editing and analysis. The first major editing task involved the soils information collected for each PSU. The soils data are used in linkage with the soils information database also maintained by the Survey Section. Editing of soils data, directed by Art Kuhl, is nearing completion, and work has begun on editing the PSU data for accuracy and consistency. Richard Dorsch is in charge of these data processing activities and is assisted by Melissa Maybee, Kathie Reinertson, and Sue Verkade.

Rather complex estimation procedures are required because of the change aspects of the 1987 NRI. Weights for estimates of totals will be constructed using control variables from the larger sample of the 1982 NRI. Software is being developed for small area estimation and for weight construction. Wayne Fuller is directing the work on estimation, assisted by Stephen Haslett and Harold Baker. Other staff members working on inventory projects during the year were Doug Bearrood, Dorothy Edwards, Nancy Hasabelnaby, Joel Halvorson, Sherry Lin, Jorge Morel, Heon Jin Park, Mark Reiser, Todd Sanger, Dan Schnell, Sahadeb Sarkar, and Gary Sullivan.

Meetings were held with SCS national office staff to begin planning for a "user friendly" computer software package that would allow users in both the public and private sectors access to the final 1987 NRI database, to be stored at the ISU Computation Center. Marvin Beck of the Computation Center has initiated the design of such a system using ORACLE.

A special project for the New Mexico Soil Conservation Service was completed. The state's resource inventory PSUs were transferred from county highway maps, on which they were originally located, to U.S. Geological Survey quadrangle maps. These maps will be used in a study of resource inventory design and methodology.

Roy Hickman traveled to Oahu, Guam, Saipan, and Palau to work from March 18 to May 1, as a member of a Soil Conservation Service team, to evaluate methodology for planning and conducting resource inventories in several South Pacific islands.

Measurement and Sampling Error

Joint research in measurement error models, time series, and survey design is supported by the U.S. Bureau of the Census and, through AES Project 2699, by the Iowa Agriculture and Home Economics Experiment Station. The bureau's support for the 1987-1988 year came through Joint Statistical Agreements J.S.A. 87-2 and J.S.A. 88-1. Wayne Fuller is principal investigator. Other personnel working on the project include Heon Jin Park, Gary Sullivan, and Nancy Hasabelnaby.

Nancy Hasabelnaby extended her dissertation work on the measurement error model with heterogeneous error variances. Theory for estimators constructed with estimated weights was derived, and the limiting distribution of the properly standardized weighted estimator is shown to be that of a multivariate normal random variable. The limit is taken as the sample size gets large and the error variances become small. Monte Carlo studies using data similar to that collected in a farm survey were employed to assess the adequacy of the asymptotic approximations. For data of the type observed in the farm survey, the large sample approximation to the distribution of the pivotal for the weighted estimator seems adequate in samples of size 50, but samples of size 200 are needed for the "t-statistic" of the unweighed estimator to behave as a random variable with a Student's t-distribution. Weighting reduces the mean square error of the regression slope and improves the t-approximation to the pivotal, relative to the unweighted procedure. There is a definite improvement even in cases where the error variance is on the order of one third of the variance of the true explanatory variables.

Gary Sullivan conducted research on the use of measurement error to protect confidentiality. Measures of the information about an individual respondent contained in a released microdata set are being studied. The construction of a computer program to add measurement error to the individual responses was initiated.

Heon Jin Park conducted research on the estimation of the mean of distributions that are right skewed. The estimation procedures are designed for

variables, such as income and size of business firms, that are regularly observed in sample surveys.

Crop Production and Livestock Estimation

George Battese collaborated with Wayne Fuller and Nancy Hasabelnaby on the estimation of livestock inventories at the state level, using data from the June Enumerative Surveys conducted by the U.S. Department of Agriculture. The research was partially supported by a research agreement with the National Agricultural Statistics Service of the USDA.

A composite estimator was proposed for livestock inventories. This estimator is obtained by a generalized least-squares regression containing the values of the different estimators in the sample years and a set of dummy variables. The precision of this estimator was investigated, under the restriction that the composite estimator yields values that are at the same level as the official estimates for livestock inventories made by the USDA. The procedures were applied to five years of data from the June Enumerative Survey.

Alternative models were investigated for the relationship between the different estimators and the livestock inventories. Estimation using the values of the estimators within the different rotation groups in the sample years was also considered.

Dietary Intake Estimation

George Battese collaborated with Wayne Fuller, Sarah Nusser, and Carol Meeter in the analysis of dietary data obtained from the Continuing Survey of Food Intakes by Individuals (CSFII) for 1985-86, conducted by the U.S. Department of Agriculture. This research was supported by a research agreement between the Center for Agricultural and Rural Development (CARD) at Iowa State University and the USDA Human Nutrition Information Service.

Attention focused on the estimation of the distribution of the usual intake of selected dietary components. Usual intake of a dietary component for an individual is defined as the long-run mean of the daily intakes for the individual. The data used in the analysis consisted of four daily intakes for a sample of individuals.

The method of moments was used as the primary estimation procedure. Moments of the average reported intakes were expressed in terms of the moments of usual intake and moments of the conditional distributions of intakes for individuals. The second and third moments of the conditional distributions of reported intakes were defined as functions of the usual intakes for the individuals. Estimators for the first four moments of usual intake were defined in terms of estimators of the parameters of the model and the sample moments of the average reported intakes of individuals.

The gamma and Weibull distributions were considered for the distributions of usual intakes and for the conditional distributions of observed intakes for individuals.

Empirical results were obtained using data from women 23 to 50 years of age, whose daily intakes were observed on four days at approximately bimonthly intervals. Five dietary components were studied: calcium, food energy, iron, protein, and vitamin C.

Wayne Fuller, George Battese, and Sarah Nusser, with Stan Johnson and Helen Jensen from CARD, gave a report on the project at the USDA Human Nutrition Information Service in Washington, D.C., on April 19-20.

Computing Research for CARD

In the summer of 1987, V. A. Sposito with Stan Johnson of CARD (the university Center for Agricultural and Rural Development) obtained a block grant funded by the ISU Computation Center. The primary goal of the grant project is to investigate and develop computational procedures to handle certain large-scaled agricultural models that have more than one objective function. Some of the objectives might be, for example, minimizing land erosion, maximizing farm income, or maximizing land usage.

Using software developed by Sposito, one can obtain an optimal solution, provided one can supply a certain preemptive structure using IBM's MPSX370E system. In situations where this structure is not defined, or the objectives are in conflict with each other, alternative computational procedures have to be considered.

Preliminary studies by Sposito showed that, once an ideal solution was found, optimizing each objective one at a time, this combined solution was never feasible. A compromise algorithm was developed, which determined solutions based on the L_p-norm and, in particular, used $p = 1, 2$, and ∞ from the desired ideal solution. For $p = 1$ and ∞, a set of nonpareto solutions will always be obtained: that is, for any $p \in [1,\infty)$, a solution that is not dominated with respect to any other efficient or nonpareto solution. A computational procedure was developed to generate a quadratic objective function based on the L_2-norm. Various models with this structure were solved using MINOS, a software package developed at Stanford University.

CARP

The program PC CARP was extended during 1987-1988. Supplements for the estimation of the logistic function and for the calculation of the variance of post-stratified estimators were made available.

PC CARP is a computer program for the analysis of survey data. It runs on the IBM PC/AT, IBM PC/XT, and compatible machines. About 50 copies have been distributed in developed countries by the Statistical Laboratory. The International Statistical Programs

Center, U.S. Bureau of the Census, has distributed more than that number of copies in developing countries.

The personal computer package EV CARP was released in the fall of 1987. This package contains parameter estimation algorithms for measurement error models. Algorithms appropriate for complex survey samples, as well as for simple random samples, are available. The program is a companion package for Wayne Fuller's book *Measurement Error Models*. Gary Sullivan, Heon Jin Park, and Nancy Hasabelnaby participated in developmental work on the CARP packages.

Spatial Statistics

Noel Cressie continued his research in spatial prediction with support from a National Science Foundation grant. Strictly speaking, all data have a spatial/temporal component; in some problems there are good physical reasons to use this extra information in the statistical model and in the inference process. Progress has been made on a two-stage estimation procedure, the first stage involving estimation of the spatial dependence structure, and the second stage yielding efficient estimation of mean parameters and efficient spatial prediction. These techniques have been applied to soil-water-infiltration data and acid-rain data. The problem of optimal design of networks of monitoring stations was also addressed. Various criteria were considered for deletion and addition of stations. Finally, a comparative study of stochastic and nonstochastic methods of spatial prediction was initiated.

Census Undercount

Two joint statistical agreements between ISU and the U.S. Bureau of the Census supported research by Noel Cressie during the year on census undercount. Research into statistical modeling of decennial census undercount has yielded an empirical Bayes model that suggests new ways to look at the 1980 census data and data from an artificial population generated by researchers at the Bureau of the Census. Constrained empirical Bayes estimators are particularly appropriate for estimating the undercount distribution across small areas. Under investigation are conditions for which adjusted counts are an improvement, on the average, over the original census counts.

Statistical Prediction

With support from a grant from the U.S. Office of Naval Research, David Harville is continuing research in the area of statistical prediction. His interest is focused on the fundamental statistical problem of predicting the value of a random variate w, based on knowledge of n observable random variables $y_1, \ldots, y_n$, where the expected values of w, $y_1, \ldots, y_n$ depend linearly on unknown parameters $\beta_1, \ldots, \beta_p$.

Point and interval predictors are available for the case where the covariance matrix V of w, $y_1, \ldots, y_n$ is known (up to a scalar multiple). However, in most applications, the elements of V are not known but rather are functions of an unknown parameter vector $\theta = (\theta_1, \ldots, \theta_m)$. In such an application, it is common practice, in predicting the value of w, to act as though an estimator $\hat{\theta}$ of θ is the true value of θ. When this practice is followed, the variance of the error of the point predictor may be understated, and the prediction interval may be overly optimistic.

The main objective of Harville's research investigation is the development of prediction procedures suitable for various cases where V is unknown.

Bootstrap and Branching Processes

A National Science Foundation grant project under the direction of Krishna Athreya supported research on bootstrap asymptotics in statistics and stochastic processes and limit theorems for branching and almost regenerative processes. The grant period extended from June 15 to November 30, 1987. Between late June and mid-July, Athreya visited the University of Rome, Italy, and London University, England, to consult with faculty members and give talks on bootstrap, branching methods, and sampling.

Bayesian Statistics

Glen Meeden completed research on admissible credible sets for a committee of Bayesian experts. This work was supported in part by a contract from the Boeing Military Airplane Company through July 31, 1987. Suppose that a decision-maker requires that a committee of Bayesian experts present a single credible set for a parameter of interest. Each expert will be allowed to announce his or her own posterior probability of the stated credible set. Two approaches to the multi-Bayesian decision problem involved were examined. An application to the problem of aircraft identification was considered.

Order Statistics and Robust Inference

For a forthcoming special issue of *Communications in Statistics* devoted to Order Statistics and Applications, H. A. David has prepared an article reviewing recent work on inequalities in order statistics requiring no or only mild assumptions. As a special feature, the paper provides unified approaches for the derivation of algebraic inequalities involving linear functions of order statistics. Various inequities for the expected value of such functions are presented. A new result is that a class of these inequities can be improved by use of a theorem for ordered sums. Additional inequalities for the expectations of ordered sums and for quantiles of sums have been obtained in work joint with Jingyu Liu.

Song-Ho Kim, under the direction of David, is investigating stochastic comparisons of order statistics. As an example of situations studied, consider $X_1, \ldots, X_n$ and $Y_1, \ldots, Y_n$, independent random samples from distributions with respective cdf's F(x) and G(x). If X is stochastically smaller than Y($X \underset{st}{\leq} Y$), i.e.,

$F(x) \geqq G(x)$ V x, then it is well known that $X_{r:n} \underset{st}{\leqq} Y_{r:n}$. Now suppose that X and Y are symmetric about 0 and that X is more peaked than Y, i.e., $F(x) \geqq G(x)$ for $x \geqq 0$. It is easy to see that neither of $X_{r:n}$, $Y_{r:n}$ is stochastically larger than the other. However, it can be shown that $E\,X_{r:n} \lessgtr E\,Y_{r:n}$ according as $r \lessgtr \frac{1}{2}(n+1)$.

Douglas Andrews has been investigating the statistical properties of a simple method [H. A. David, *Biometrika,* 1987] for ranking from unbalanced paired-comparison data. Comparisons with other possible methods are also being made.

S. S. Winston Yang, visiting professor, began investigating a new class of nonparametric procedures for comparing two survival distributions F and G when the corresponding two data sets are randomly censored by separate sets of censoring variables. Tests developed do not assume proportionality of the hazard functions of F and G nor equality of the distributions of the two sets of censoring variables. Comparisons will be made with the tests due to Gehan, Mantel and Haenszel, and Cox, and with the log rank test.

Research on these projects is supported by the U.S. Army Research Office.

Survival Analysis

Kenneth J. Koehler is principal investigator for a research project on parametric survival analysis for smoking cessation data. This investigation is supported by a grant from the National Institute of Drug Abuse, U.S. Department of Health and Human Resources. The objective is to develop methods of analyzing possibly correlated and censored survival data obtained when treatments are applied to groups of subjects. Resampling methods are being used to obtain appropriate standard errors and confidence intervals for model parameters.

Sciences and Humanities Research Institute

Funds from the Sciences and Humanities Research Institute help support research by Yasuo Amemiya, Krishna Athreya, H. A. David, Mervyn Marasinghe, and Glen Meeden. Much of their work also received support from federal grants in 1987-88 and has already been described in this section.

Yasuo Amemiya continued research in factor analysis, multivariate functional and structural relationships, and multivariate components of variance. He completed collaborative work with T. W. Anderson, Stanford University, on the properties of normality-based inference procedures applied to nonnormal factor-analysis-type models. The limiting distribution of the likelihood ratio test of the rank of the between-group covariance matrix was also studied by Amemiya and Anderson. For the nonlinear functional relationship model, an improved instrumental variable estimator was proposed and its properties were investigated.

Krishna Athreya worked on developing a central limit theorem for Polya urn schemes. This work was partially supported by the National Science Foundation.

Mervyn Marasinghe continued research collaboration with Robert Boik, Montana State University, on topics related to nonadditivity in multiway tables. He also started new work with Charles Farmer, James Madison University, on nonadditivity in multivariate linear models.

Dean Isaacson and Glen Meeden worked on the problem of approximating posterior distributions. For many Bayesian problems it is convenient to have available a reasonable approximation to the posterior. In the one-dimensional case the standard approximation is the Normal approximation. Isaacson and Meeden studied modifications of the standard approximation that are appropriate when the posterior is not symmetric. The technique employed suggests a method of expanding the class of conjugate priors that is flexible and computationally convenient.

Other Research

Noel Cressie presented written testimony to the Congressional Hearing on the Impact of Population Undercount, a hearing called by the U.S. House of Representatives Committee on Post Office and Civil Service, Subcommittee on Census and Population, in San Francisco, California, on August 17, 1987.

Stephen Haslett has been working in two research areas: time series methods applied to repeated sample surveys, and new estimators for probability proportional to size with replacement sampling.

J. Marcus Jobe, assistant professor, Department of Production and Decision Science, Miami University of Ohio, spent two weeks in the Statistical Laboratory in July 1987 engaged in research on reliability/maintainability problems with H. T. David and Stephen Vardeman. This work was part of Jobe's Air Force Office of Scientific Research fellowship grant project. Jobe completed his doctorate in statistics here in 1984, with David and Vardeman as his major professors.

William Q. Meeker, Jr., continues to collaborate with Luis A. Escobar (Louisiana State University) in doing research on regression diagnostic methods for censored regression data.

While at Stanford University, Frederick Lorenz worked with sociology colleagues on aspects of the institutional theory of organizational change. During June 1988, he worked with ISU colleagues in family environment and sociology on a National Institute of Drug Abuse grant project investigating rural family economic stress and adolescent drug abuse. Lorenz's role was to direct data analysis in support of the pre-test evaluation of measurement instruments.

Mack Shelley continues to conduct research in a number of areas related to biotechnology, with emphases on biotechnology's impacts on economic devel-

opment and on university structures and operations. A new survey of Iowa state legislators was conducted to generate data on their expectations and perceptions about the role of biotechnology in the state. This survey supplements data on the attitudes toward biotechnology held by Iowa farm operators, Iowa State University faculty, administrators, and graduate students, and chief executive officers and research directors in biotechnology companies throughout the U.S.

Results have been presented at a number of conferences. A major research bibliography on the socioeconomic and political implications of biotechnology, coauthored with William F. Woodman and Brian J. Reichel, is forthcoming from Iowa State University Press.

Other research currently underway by Shelley concerns elections in both the United Kingdom and the United States, decision-making in Congress, and urban migration.

Leroy Wolins received a $10,000 grant from the Iowa Utilities Association in 1987 for research on the low income energy assistance program.

Carl Roberts is currently working with a faculty member in computer science on a microcomputer-based program for linguistic content analyses.

A grant to Roberts from the ISU Achievement Foundation provides funding for an investigation of the origins of secularization in the Netherlands and the United States. The research is being performed in collaboration with the Katholieke Universiteit in Nijmegen, the Netherlands. Analyses will seek to determine why, during the past few decades, American religiosity has remained high, whereas Dutch society has become progressively secular. The role that secularization has played in the formation of political attitudes will also be explored.

Robert Strahan's current research includes the assembling of some classroom techniques for illustrating certain statistical concepts (e.g., regression to the mean), continuing investigation of the properties of a portable electrical skin conductance device for measuring physiological arousal, and construction of a graphic display dramatizing the similarity (and dissimilarity) of topical interests of American Psychological Association men and women. Regarding the latter, the display shows at a glance what the corresponding tables reveal but grudgingly: that men and women are generally quite similar in the extent to which (as indicated by numbers of divisional members) certain areas are of interest. A single, striking exception is women's much greater membership in the division Psychology of Women. Some divisions that men belong to relatively more than women do are Industrial and Organizational, Experimental, Experimental Analysis of Behavior, Clinical, and Engineering; some divisions that women belong to relatively more than men do are School, Psychoanalysis, and Developmental.

Professional Activities

Wayne Fuller continues to serve as a member of Statistics Canada's Advisory Committee on Statistical Methods and attended meetings in Ottawa on October 5-6 and April 17-18. As a member of the National Research Council's Panel on Decennial Census Methodology, he attended a panel meeting in Washington, D.C., on February 11-12.

Fuller was elected chair-elect of the American Statistical Association Section on Survey Research Methods for 1988. He was also elected to the Institute of Mathematical Statistics Council for 1987-1990.

Noel Cressie agreed to serve on the ASA Committee on Energy Statistics for the term January 1988 through December 1990. The committee considers energy statistics as they relate to energy policy analysis and the framing of a comprehensive energy data system. Its primary federal advisory responsibility is to the Energy Information Administration of the U.S. Department of Energy. Cressie attended a meeting of the committee in Washington, D.C., April 28-29.

H. A. David is vice-chair of the ASA Committee on Archives. Herbert T. David chaired a search committee in 1988 to fill the general editor position for the *Journal of the American Statistical Association*. Stephen Vardeman continued to serve on the ASA Committee on Award for Outstanding Statistical Application. Since 1984 W. Robert Stephenson has served on the ASA Committee to Prepare Guidelines for Undergraduate Programs in Statistics.

In fall 1987 Kenneth J. Koehler completed a two-year term as the Iowa Chapter's representative to the ASA's Council of Chapters.

Under American Statistical Association sponsorship, Wayne Fuller, Steve Miller (U.S. Bureau of Labor Statistics), and Dan Schnell (Centers for Disease Control) gave a short course on Measurement Error Models at the 1987 joint statistical meetings in San Francisco. Videotapes of this short course are available through ASA. On August 18, Noel Cressie presented a two-hour tutorial under the same sponsorship: "Spatial Prediction and Kriging."

Fuller gave a short course on "PC CARP" in Tokyo, Japan, September 11 for statisticians from developing countries. He presented a two-week short course, "Sampling and measurement error," for Latin American statisticians November 16-27 at CIENES, in Santiago, Chile.

Krishna Athreya is a member of the National Science Foundation's Science and Technology Center panel for 1988; the panel selects university centers to be funded by NSF. He attended the panel's meeting on March 29-31 in Washington, D.C. Athreya was also

chosen to serve for a three-year term, beginning in April, on a panel of the NSF Conference Board on Mathematical Sciences, which selects lecture series for NSF support. He attended a board meeting in Washington, D.C., on June 3-4.

William Q. Meeker, Jr., and Stephen Vardeman attended the Gordon Research Conference on Statistics in Chemistry and Chemical Engineering, held in New Hampton, New Hampshire, July 27-31,1987. Meeker served as a moderator.

On May 9-13, 1988, Herbert T. David served as visiting scientist on the staff of the Statistical Engineering Division, National Bureau of Standards, in connection with a conference hosted by the bureau on Uncertainty in Engineering Design.

Noel Cressie is a member of the Scientific Committee for the Third International Geostatistics Congress, to be held in Avignon, France, September 5-9, 1988. He is also on the organizing committee for the 1989 summer workshop on Robustness, Diagnostics, Computing and Graphics in Statistics that will be sponsored by the Institute for Mathematics and Its Applications, University of Minnesota.

W. Robert Stephenson continued to serve as director-at-large on the Board of Directors of Mu Sigma Rho, the national statistics honor fraternity.

Krishna Athreya gave a set of lectures on Markov chains at the University of Rome, Italy, for its Department of Mathematics June 12-24, 1988.

Mary Genalo received an ISU Professional and Scientific Continuing Education grant to attend the International Conference on Telephone Survey Methodology held on November 8-11, 1987, in Charlotte, North Carolina.

Mack Shelley II continued to serve as the Iowa State University Official Representative to the Inter-University Consortium for Political and Social Research. He also continued to serve as a member of the ISU Ethical Issues in Biotechnology Committee.

Papers Presented, Lectures, and Seminars

At the 1987 joint statistical meetings of the American Statistical Association, the Biometric Society (ENAR and WNAR), and the Institute of Mathematical Statistics in San Francisco, California, August 17-20:

BAILEY, Theodore B. Jr.: "Statistics and biotechnology";

CRESSIE, Noel A. C.: "Statistics for spatial data"; also discussant, JASA Applications Invited Paper session ("Census undercount adjustment and the quality of geographic population distributions," by A. L. Schirm and S. H. Preston);

Crowder, Stephen V. (Corning Glass Works): "A simple method for studying run length distributions of exponentially weighted moving averages";

DAVID, H. A.: "Ranking from unbalanced paired-comparison data";

Eltinge, John L.: "Measurement error models for time series";

Farmer, Charles M. (University of Kentucky), and **Mervyn G. MARASINGHE:** "Tests for nonadditivity in the unreplicated two-way mixed model";

Jeske, Daniel R., and **David A. HARVILLE:** "Mean-squared error of estimation and prediction under a general linear model";

KOEHLER, Kenneth J., and **F. Gan** (Iowa State University and National University of Singapore): "Chi-squared goodness-of-fit statistics: Cell selection and power"; also Koehler, chair, session on Generalized Linear Models—Contributed Papers;

Lee, Mong-Hong: "Strongly consistent modified maximum likelihood estimation of U-shaped hazard functions";

MARASINGHE, Mervyn G., and Robert J. Boik: "Three-way nonadditivity—Part 1: An extension of Tukey's single degree of freedom test";

Boik, Robert J., and **Mervyn G. MARASINGHE:** "Three-way nonadditivity—Part 2: A modified likelihood ratio test";

MEEDEN, Glen, and **Stephen VARDEMAN:** "Using the 'Polya posterior' in finite population sampling for point and set estimation problems";

Escobar, Luis A., and **William Q. MEEKER, Jr.:** "Assessing local influence in regression analysis with censored data";

MEEKER, William Q. Jr.: chair/organizer of the *Technometrics* Invited Paper session;

Morel, Jorge G., and **Kenneth J. KOEHLER:** "Generalized least squares methodology for discrete multivariate data";

Nagaraj, Neerchal K. (University of Maryland-Baltimore), and **Wayne A. FULLER:** "Estimation of linear models with nonlinear restrictions on the parameters";

REISER, Mark, and Ron Fecso: "Nested error models for the Objective Yield Survey";

SHELLEY, Mack C. II: "A nonparametric view of elections to the U.S. House of Representatives";

Crowder, Lee J., and **V. A. SPOSITO:** "Obtaining least absolute deviation estimates";

STEPHENSON, W. Robert: "Student reactions to the use of MINITAB in an introductory statistics course";

SUKHATME, Shashikala: "Application of perturbation theory in statistics";

Zimmerman, Dale (Iowa State University and University of Iowa): "Computationally exploitable structure of covariance matrices in spatial models".

At the Joint Sino-American Statistical Meeting, Beijing, China, held on August 31-September 2, 1987:

CRESSIE, Noel A. C.: "Spatial data analysis and modeling of regional variables."

FULLER, Wayne A., and **Carol A. Francisco** (Syntex Laboratories, Inc.): "Estimation of quantiles with survey data";

At the 46th Session of the International Statistical Institute, Tokyo, Japan, held September 8-16, 1987:

CRESSIE, Noel A. C.: "Estimating undercount in the U.S. Decennial Census."

FULLER, Wayne A., Dan Schnell, Gary Sullivan, and William

J. KENNEDY: "Survey variance computations on the personal computer";

At the Midwest Sociological Society meeting, Minneapolis, Minnesota, held March 23-26, 1988:

ROBERTS, Carl W.: "Why scientists disagree: Reflections on the structure of scientific discourse";

"Writing research for the first time: An outline for undergraduate research."

At other locations:

ATHREYA, Krishna: "Bayesian approach to finite population sampling" and "On the maximum sequence in a critical branching process," seminars for the Department of Mathematics, University of Rome, Italy, July 1 and 2, 1987, respectively.

"On bootstrap, finite population sampling, and branching processes: A survey of recent results," seminar for the Department of Statistics, Birkbeck College, London University, England, July 12.

"Central limit theorem for Polya posteriors," colloquium talk for the Division of Statistics, University of California-Davis, March 23, 1988.

"Renewal and branching processes," at the 17th International Conference on Stochastic Processes and Its Applications," held in Rome, Italy, June 27-July 1, 1988.

BATTESE, George E.: "Prediction of firm-level technical efficiencies, given a generalized frontier production function and panel data," seminar for the Econometrics Workshop, Department of Economics, Michigan State University, October 8.

Carriquiry, Alicia L.: "Bayesian prediction of breeding values when variances are unknown," seminar, Department of Animal Science, University of Illinois, March 11, 1988.

COX, David F.: "Statistics as a mode of thought in ecological research," Animal Ecology Seminar, Iowa State University, February 19, 1988.

CRESSIE, Noel: "In search of generalized covariances for kriging" and "Spatial analysis of data on lattices," seminars for the Department of Statistics, University of Washington, July 22 and 23, 1987.

Informal lecture on geostatistics, Department of Statistics, University of British Columbia, Canada, July 27.

"Statistics for spatial data," seminar for a meeting of the Statistical Society of Australia, in Perth, August 27.

"Analysis of spatial data," seminar for the departments of Statistics and Actuarial Science and Biostatistics (Epidemiology and Preventive Medicine), University of Iowa, October 8, 1987.

"Some recent developments in spatial statistics," at the 1987 Midwest Statistics Conference, in Champaign, Illinois, October 10.

"Modeling growth with random sets," seminar for the departments of Statistics at Stanford University, Pennsylvania State University, and Texas A&M on February 3, 11, and 25, 1988, respectively.

"Estimating census undercount at national and subnational levels," at the Fourth Annual Research Conference of the Bureau of the Census, in Arlington, Virginia, March 21, and at the joint meeting of the Iowa sections of the Mathematics Association of America and the American Statistical Association, Grinnell, Iowa, April 16.

"Modeling tumor growth with random sets," at the 1988 Central Regional Meeting of the Institute of Mathematical Statistics, cosponsored by SIAM, in Madison, Wisconsin, May 16.

"Modeling growth with random sets," at the American Mathematical Society Conference on Spatial Statistics and Imaging, cosponsored by the Institute of Mathematical Statistics and SIAM, Brunswick, Maine, June 20.

DAVID, H. A.: "Ranking and selection from paired-comparison data," at the Second International Advanced Seminar/Workshop on Inference Procedures Associated with Statistical Ranking and Selection, in Sydney, Australia, August 10, 1987.

"Paired comparisons and tournaments," the annual Inter-University Seminar jointly organized by McMaster University and the universities of Waterloo, Guelph, and Western Ontario, in Hamilton, Ontario, Canada, April 15, 1988.

DAVID, H. T.: "Cesaro limits of marked point processes on the line," seminar for the departments of Decision Sciences and Mathematics and Statistics, Miami University (Ohio), November 9, 1987.

"Game theory—rationale and rationality" and "Statistics in the industrial enterprise," for the School of Business of the University of Alberta, Canada, February 15 and 16, 1988.

"Moisture content as predictor of coal hydrophobicity," by B. C. J. Labuschagne, T. D. Wheelock, **R. K. Guo,** David, and R. Markuszewski, at the 13th International Conference on Coal and Slurry Technology, held by the Coal and Slurry Technology Association in Denver, Colorado, April 12-15.

ELTINGE, John L.: "Measurement error models for time series," seminar at the Alcoa Technical Center, Alcoa Center, Pennsylvania, December 17, 1987, and at the Eli Lilly Research Laboratories, Indianapolis, Indiana; the National Bureau of Standards, Washington, D.C.; Bell Laboratories in Murray Hill, New Jersey; and DuPont Research Laboratories, Newark, Delaware, in January 1988; also as a seminar for the departments of Statistics at Northwestern University and North Carolina State University on January 18 and February 11, respectively.

FULLER, Wayne A.: "Estimation for a quantitative study with quantitative response," at the National Institutes of Health Workshop on Errors in Variables, October 8, 1987, in Bethesda, Maryland.

"Gamma post stratification," by Fuller and **Gary Sullivan** at the Seminar in Honor of the 25th Anniversary of CIENES, in Santiago, Chile, November 13.

"Introduction to measurement error models," seminar for the International Mathematical & Statistical Libraries, Inc. (IMSL), Houston, Texas, February 5, 1988.

"Computing complex statistics with complex survey data," seminar at the Economics Research Service, U.S. Department of Agriculture, Washington, D.C., February 10.

"Estimation of quantiles with complex survey data," seminar, Department of Statistics, University of Michigan, March 9, and "Introduction to measurement error models," seminar to the Department of Biostatistics there, March 10.

"Regression analysis of time series," at a meeting on Analysis of Time-Dependent Data, sponsored by the Delaware Chapter of the American Statistical Association, April 22.

HARVILLE, David: "Statistical prediction," an applied mathematics seminar at the U.S. Naval Surface Weapons Center, Silver Spring, Maryland, July 30, 1987.

"Computational aspects of likelihood-based inference for variance components," seminar presented to the Department of Statistics and Actuarial Science, University of Iowa, March 10, 1988, and to the Department of Statistics, University of Tennessee, April 7.

Hasabelnaby, Nancy A., Wayne A. FULLER, and James H. Ware: "Indoor air pollution and pulmonary performance: Investigating errors in exposure assessment," at the Biometric Society (ENAR) spring meeting, Boston, Massachusetts, March 28, 1988.

HASLETT, Stephen: "Degrees of freedom in sparse complete contingency tables," at the joint meeting of the Iowa sections of the Mathematics Association of America and the American Statistical Association, Grinnell, Iowa, April 16.

HINZ, Paul N.: Lectures on experimental design and careers in statistics, Department of Mathematics, Luther College, November 19, 1987.

"Comparison between factor analysis from a phenotypic and genetic correlation matrix using linear type traits of Holstein dairy cows," by M. Sieber, A. E. Freeman, and Hinz, at the 82nd annual meeting of the American Dairy Association, held in Columbia, Missouri, June 21-24, 1988.

KENNEDY, William J.: "Expert statistical methods and software," seminar, Department of Statistics, Kansas State University, March 31.

MEEDEN, Glen: "Using the 'Polya posterior' in point and set estimation problems in finite population sampling," seminar, U.S. Bureau of Labor Statistics, Washington, D.C., October 26, and talk given at the 34th meeting of the National Bureau of Economic Research-National Science Foundation Seminar on Bayesian Inference in Econometrics, Gainesville, Florida, October 30, 1987.

"Using the 'Polya posterior' in point and set estimation problems in finite population sampling," seminar, Department of Statistics, University of Minnesota, March 10, 1988.

MEEKER, W. Q.: "Using the SAS system to assess local influence in regression analysis with censored data," by L. A. Escobar and Meeker, at SUGI 1988, the SAS User's Group International Conference, in Orlando, Florida, March 29.

POLLAK, Edward: "Some theory for populations without a Hardy-Weinberg structure," Ecology and Evolutionary Biology Seminar, Iowa State University, December 3, 1987.

SACKS, Jerome M.: "Prevalence estimation using pooled data," seminar, National Animal Disease Center, Ames, Iowa, November 2, 1987.

"Estimating DNA and protein molecular weight by gel plate electrophoresis," seminar, Department of Veterinary Microbiology and Preventive Medicine, Iowa State University, spring 1988.

SHELLEY, Mack II: "Recent attitudinal survey on bioethics," by Shelley and William Woodman, Bioethics Seminar, Iowa State University, October 2, 1987.

"The new faith in high technology: Biotechnology and Iowa," by Brian J. Reichel, William F. Woodman, Shelley, and Paul Lasley, at the Midwest Regional Conference of the American Society for Public Administration, held in Minneapolis, Minnesota, in October 1987.

"University-industry relationships (UIRs) in biotechnology: Convergence and divergence in goals," by William Woodman, Brian Reichel, and Shelley, and "Perceptions of the role of university research in biotechnology: Town, gown, and industry," by Shelley, Reichel, and Paul Lasley—presented on November 3 and 4 at the Iowa State University Agricultural Bioethics Symposium.

"Iowa farmers' attitudes about pesticides and clothing: Perception of risk, benefit, and safety practices," by Janis Stone and Shelley, at the First International Symposium on the Impact of Pesticides, Industrial and Consumer Chemicals in the Near Environment, held in Orlando, Florida, February 10-12, 1988.

"Research parks and economic development: The case of biotechnology," by Shelley, William F. Woodman, and Brian J. Reichel, presented at the Annual Conference of the Western Governmental Research Association, held March 13-16 in San Francisco, California.

"Biotechnology and the cooptation of the university," by Brian J. Reichel, William F. Woodman, and Shelley—poster session presentation, National Conference of the American Society for Public Administration, April 19, 1988.

SPOSITO, V. A.: "Comparisons of L_1 computational algorithms," by Sposito, J. E. Gentle, and Subhash Narula, at the First International Conference on Statistical Data Analysis Based on the L_1-Norm and Related Methods, Neuchatal, Switzerland, August 31, 1987.

STEPHENSON, W. Robert: "Experimental design and quality improvement: The Taguchi phenomenon," guest lecture for I Engrg 361, Department of Industrial Engineering, Iowa State University, April 25, 1988.

STRAHAN, Robert F.: "Psychologists' interpretations of P-values" and "Portable arousal measure for exercise and sport psychology: Validational data," at the 1987 annual meeting of the American Psychological Association, New York, New York, August 28 and 31, respectively.

"Judged and actual relations among effect strength measures," at the annual meeting of the Iowa Educational and Research Evaluation Association, November 13 in Iowa City, Iowa.

VARDEMAN, Stephen B.: "Some comments on the 'Taguchi philosophy and methods'," seminar, Procter and Gamble Winton Hill Technical Center, Cincinnati, Ohio, September 18, 1987.

"Some variations on an old optimal control problem," seminar, Department of Statistics, University of Kentucky, March 24, 1988.

"The discipline of statistics and engineering research," seminar, Department of Materials Science and Engineering, Iowa State University, April 19.

"Some comments on the Taguchi philosophy and methods," seminar for the Northern Illinois Chapter of the American Statistical Association, Chicago, Illinois, April 28.

White, Susan E.: "Evaluation of a soil moisture model," by White, T. S. Colvin, and **J. SACKS,** December 8, 1987, at the 3rd International Workshop on Land Drainage, held at Ohio State University and sponsored by the American Society of Agricultural Engineers.

WOLINS, Leroy: "Treatment compliance in a child guidance center as a function of demographic and intake variables," by Vera Joffe, Norman A. Scott, and Wolins, at the Florida Conference on Health Psychology, held in Gainesville, Florida, in April 1988.

Other Meetings

Song Ho Kim attended the Symposium on Dependence in Statistics and Probability sponsored by the U.S. Air Force Office of Scientific Research, National Science Foundation, U.S. Army Research Office, and University of Pittsburgh, held in Somerset, Pennsylvania, August 1-5.

Jerome Sacks attended the 6th International Conference on Mathematical Modelling, held on August 4-7 in St. Louis, Missouri. On September 16-17 he attended the USDA-Agricultural Research Service Biometricians' Meeting in Beltsville, Maryland.

Wayne Fuller attended the National Science Foundation/National Bureau of Economic Research Time Series Seminar held in Raleigh, North Carolina, on October 16-18.

William Q. Meeker chaired the *Technometrics* session at the Fall Technical Conference sponsored by the American Society for Quality Control and the American Statistical Association and held in Atlantic City, New Jersey, October 21-23.

Krishna Athreya and Patrick Homblé attended the ninth Midwest Probability Colloquium October 22-24 in Evanston, Illinois.

Theodore Bailey attended the 1988 winter conference of the American Statistical Association in San Antonio, Texas, January 6-8, including two continuing education tutorials on biotechnology and experimental design and on bioassay methodology. Also attending the conference were Douglas Andrews, Chong Sun Hong, Karen Jensen, Nuwan Nanayakkara.

Wayne Fuller attended a meeting of the executive committee of the Survey Research Methods Section, American Statistical Association, in Washington, D.C., March 3-4.

David F. Cox attended the 21st Meeting (Midwestern Sectional) of the American Society of Animal Science on March 22 in Des Moines, Iowa.

Jerome Sacks conducted two sessions during the Midwest Area Leadership Meeting held by the USDA-ARS in Lake Geneva, Wisconsin, April 12-14. One was an open question/answer session for design/analysis issues, the other a workshop including a PC/SAS demonstration.

Glen Meeden attended the 36th meeting of the National Bureau of Econometric Research-National Science Foundation Seminar on Bayesian Inference in Econometrics, in Ann Arbor, Michigan, April 21-23.

On May 25-27, Sacks took part in the Midwest Biopharmaceutical Statistical Workshop held in Muncie, Indiana.

Stephen Vardeman went to the Quality and Productivity Research Conference held at Oakland University on June 2-5.

V. A. Sposito attended the 1988 World Food Conference held in Des Moines, Iowa, June 5-9.

After attending a pre-conference Animal Model Workshop on June 25-26, Donald Hotchkiss went to the annual meeting of the American Dairy Science Association, in Edmundton, Alberta, Canada, on June 26-29.

Publications and Dissertation Abstracts

Editorial activities preoccupied many of the faculty members. William Q. Meeker, Jr., continued as editor of *Technometrics,* with Denise Riker as editorial assistant. Stephen Vardeman continued as an associate editor. Meeker is also on the editorial board of *Selected Tables in Mathematical Statistics.*

In 1987 William J. Kennedy completed his term as editor of *The American Statistician,* with Darlene Wicks as editorial assistant. Glen Meeden, Vincent Sposito, and Stephen Vardeman completed duties as associate editors, while Yasuo Amemiya continues as associate editor. Kennedy remains on the international editorial board of *Communications in Statistics—Simulation and Computation* and is coeditor of its Algorithms section.

Noel Cressie is an associate editor of the *Journal of the American Statistical Association* Theory and Methods Section and is on the editorial board of *Chemometrics and Intelligent Laboratory Systems.*

H. A. David is a member of the editorial board for the *Journal of the Indian Society of Agricultural Statistics.*

Paul Hinz completed 8 years of service as an associate editor of the *Iowa State Journal of Research,* which ceased publication in 1988.

Wayne Fuller continued as associate editor of *Survey Methodology* and the *Journal of Business and Economic Statistics.*

Krishna Athreya is an associate editor of *Probability Theory and Related Fields* and serves on the editorial board of *Statistics & Probability Letters.*

Oscar Kempthorne is an associate editor of the *Journal of Statistical Planning and Inference* and a member of its executive committee. He is also on the editorial advisory board of the *Journal of Statistical Computation and Simulation.*

Edward Pollak continues to serve on the editorial board of *Mathematical Biosciences.*

Mark Reiser is a member of the editorial board for *Sociological Methods & Research.*

Leroy Wolins is a member of the board of editors for *Educational and Psychological Measurement.*

In the preprint series initiated by the Statistical Laboratory in 1986, 26 titles were added during 1987 and 13 more in the first half of 1988. Information on the first 26 of these technical reports is contained in a

set of abstracts covering #87-1 to 26. Copies are available on request. Any preprint may be requested by number directly from the author. A new set of preprint abstracts will be released in fall 1988.

Books

Read, Timothy R. C., and **Noel A. C. CRESSIE.** *Goodness-of-Fit Statistics for Discrete Multivariate Data.* Springer-Verlag (New York). 1988. xii + 212 pp.

The statistical analysis of discrete multivariate data has received a great deal of attention in the statistics literature over the past two decades. Those books that emphasize model development tend to assume that the model can be tested with one of the traditional goodness-of-fit tests (e.g., Pearson's X^2 or the loglikelihood ratio G^2) using a chi-squared critical value. However, it is well known that this can give a poor approximation in many circumstances. The present book concentrates on the description and assessment of the goodness-of-fit statistics used in the model verification part of the inference process.

The book provides readers with a unified analysis of the traditional goodness-of-fit tests, describing their behavior and relative merits, and introduces some new test statistics. The power-divergence family of statistics (Cressie and Read, *Journal of the Royal Statistical Society B* 46, 440-464, 1984) is used to link the traditional test statistics through a single real-valued parameter, and provides a way to consolidate and extend the current fragmented literature. As a byproduct of the authors' analysis, a new statistic emerges "between" Pearson's X^2 and the loglikelihood ratio G^2 that has some valuable properties.

In addition, a number of new results are presented. These include a unified treatment of the minimum chi-squared, weighted least squares (minimum modified chi-squared), and maximum likelihood approaches to parameter estimation; a detailed analysis of the contribution made by individual cells to the power-divergence statistics, including Poisson-distributed cell frequencies with small expected values; and a geometric interpretation of the power-divergence statistic. Chapter 8 proposes new directions for future research, and a Historical Perspective chapter gives a literature survey on the most famous members of the power-divergence family, namely, Pearson's X^2 and the loglikelihood ratio statistic G^2. Pearson's X^2 is reappraised from the authors' new perspective.

The book is aimed at applied statisticians and graduate students in statistics, as well as statistically sophisticated researchers and students in other disciplines, such as the social and biological sciences. The interpretation and application of goodness-of-fit statistics for discrete multivariate data are emphasized. Detailed proofs are deferred to the Appendix section.

DAVID, H. A. *The Method of Paired Comparisons,* 2nd edition. Charles Griffin (London), Oxford University Press (New York). 1988. viii + 188 pp.

The first edition of this monograph was published 25 years ago. Since then, parametric approaches, especially those based on the Bradley-Terry model, have been greatly developed, allowing for much increased flexibility including multivariate generalizations. These procedures, as well as mathematical programming techniques requiring milder model assumptions, are described. The distinctive emphasis of the revised and expanded edition continues to be on simple nonparametric procedures and on the analogy between paired comparisons and tournaments.

HUNTSBERGER, DAVID V., and Patrick P. Billingsley. *Elements of Statistical Inference.* Boston: Allyn and Bacon, Inc. (1987), sixth edition. xvi + 511 pp.

Bardes, Barbara A., **Mack C. SHELLEY II,** and Steffen W. Schmidt. *American Government and Politics Today: The Essentials.* St. Paul: West (1988), second edition. xxix + 541 pp.

This is an update of the 1986 first edition. Part Three has been reorganized with separate chapters on public opinion and on special-interest groups. Elements of several previous chapters were combined into a revised chapter on campaigns, voting behavior, and elections. The chapter on public policy has been extensively rewritten to provide more complete coverage of contemporary policy concerns. Enrichment lectures, including full references and transparencies, are an innovation in this edition.

Reichel, Brian J., William F. Woodman, and **Mack C. SHELLEY.** *Research Through Biotechnology: Institutional Impacts and Societal Concerns—A Guide to the Literature.* Ames, Iowa: Bibliographies in Technology and Social Change Series, No. 1, Technology and Social Change Program, Iowa State University (1988). viii + 139 pp.

This is a reference bibliography for researchers in biotechnology ethics and policy, with emphasis on relationships between biotechnology industries and universities engaged in research leading to technology transfer, and the role of government policy in regulating biotechnology.

Published Research

Abdurachman, Edi (Centre for Agricultural Data Processing, AARD, Jakarta, Indonesia), and **H. T. DAVID.** Cesaro limits of marked point processes on the line. *Communications in Statistics—Stochastic Models* 4:1 (1988) 77-98.

A simple marked point process on the line (SMPPL) may be viewed as borrowing from semi-Markov processes the structure of a positive-valued waiting time process $\{W_n\}$ modeling random delays between the state changes of a "mark process" $\{J_n\}$. Conditions are given ensuring that Cesaro limits with respect to time of state probabilities of a SMPPL are of a form analogous to limiting state probabilities

of semi-Markov processes. These conditions include a condition restricting attention to "essentially finite" state spaces, in the sense of requiring a finite expected number of distinct visited states. Four examples are given, of which the first illustrates the extent to which a SMPPL satisfying our conditions may differ from a semi-Markov process. The remaining three examples are drawn from inventory theory, reliability, and material science.

AMEMIYA, Yasuo, and **Wayne A. FULLER.** Estimation for the nonlinear functional relationship. *The Annals of Statistics* 16:1 (1988) 147-160.

Estimation of the parameters of the nonlinear functional model with known error covariance matrix is discussed. Asymptotic properties of the maximum likelihood estimator for the implicit functional model are presented. The approximate bias in the maximum likelihood estimator due to the nonlinearity of the relationship is given and a bias-adjusted estimator is suggested. Numerical and theoretical results support the superiority of the bias-adjusted estimator relative to the maximum likelihood estimator.

Anderson, T. W., and **Yasuo AMEMIYA.** The asymptotic normal distribution of estimators in factor analysis under general conditions. *The Annals of Statistics* 16:2 (1988) 759-771.

Asymptotic properties of estimators for the confirmatory factor analysis model are discussed. The model is identified by restrictions on the elements of the factor loading matrix; the number of restrictions may exceed that required for identification. It is shown that a particular centering of the maximum likelihood estimator derived under assumed normality of observations yields an asymptotic normal distribution that is common to a wide class of distributions of the factor vectors and error vectors.

In particular, the asymptotic covariance matrix of the factor loading estimator derived under the normal assumption is shown to be valid for the factor vectors containing a fixed part and a random part with any distribution having finite second moments and for the error vectors consisting of independent components with any distributions having finite second moments. Thus the asymptotic standard errors of the factor loading estimators computed by standard computer packages are valid for virtually any type of nonnormal factor analysis. The results are extended to certain structural equation models.

ATHREYA, K. B. (ISU, Indian Statistical Institute, and the Mathematical Sciences Research Institute, Berkeley). On the maximum sequence in a critical branching process. *The Annals of Probability* 16:2 (1988) 502-507.

If M_n is the maximum population size among the first n generations, then it is shown under a finite second-moment condition that the mean value of M_n grows at a logarithmic rate. This finding improves earlier results of H. Wiener and A. Pakes.

ATHREYA, Krishna B. Modified Bessel function asymptotics via probability. *Statistics & Probability Letters* 5:5 (1987) 325-327.

Using the local and global versions of the central limit theorem it is shown that, for the modified essel function $I_\rho(x)$,

(i) for fixed ρ, $I_\rho(x)e^{-x}\sqrt{x} \to (\sqrt{2\pi})^{-1}$ as $x \to \infty$,

(ii) $I_{a(x)}(x)\sqrt{x}\, e^{-x} \to (\sqrt{2\pi})^{-1} e^{-a^2/2}$ and

$$\sum_{0 \le j \le a(x)} I_j(x)e^{-x} \to \Phi(a) - 2^{-1} \text{ if } a(x)/\sqrt{x} \to \alpha,$$

$0 \leqq \alpha \leqq \infty$ as $x \to \infty$.

ATHREYA, K. B. Bootstrap of the mean in the infinite variance case. *Proceedings of the First International Congress on Probability and Statistics,* held by the Bernoulli Society, Vol. 2, pp. 95-98. 1987.

Let $X_1, X_2, \ldots, X_n$ be independent identically distributed random variables belonging to the domain of attraction of a stable law of order α, $0 < \alpha < 2$. Given $X_1^n \equiv (X_1, X_2, \ldots, X_n)$, let $Y_1, Y_2, \ldots, Y_n$ be i.i.d. with distribution $P(Y_1 = X_j | X_1^n) = n^{-1}$ for $j = 1,2, \ldots, n$. This paper shows that there exist a_n and b_n such that if $H_n(x,\omega) \equiv P(n(\bar{Y}_n - b_n) \leqq a_n x | X_1^n)$ then there is a random infinitely divisible distribution function $H(x,\omega)$ such that $H_n(\cdot,\omega)$ converges to $H(\cdot,\omega)$ in the Skorohod space $D(-\infty,\infty)$. This shows that the bootstrap method for the sample mean fails when $\alpha < 2$. The case $\alpha = 2$ and other related results are also discussed.

ATHREYA, Krishna B. Hitting times of decreasing sets for regenerative processes. *Journal of Applied Probability* 25:1 (1988) 89-96.

Let $\{X(t): t \geqq 0\}$ be a regenerative process with excursion process $\{Y(u): 0 \leqq u < T, T\}$ and state space $(S, \tilde{S})$. Let A_n be a sequence of sets in $\tilde{S}$ such that $p_n = P(Y(u) \varepsilon A_n \text{ for some } 0 \leqq u < T) \to 0$. Let V_n be the hitting time of A_n for the process X. This paper gives a variety of conditions on the excursion process Y to obtain limit theorems for V_n. Apart from obtaining an exponential limit in the positive recurrent case, i.e., $ET < \infty$, some nonexponential limits are obtained in the null recurrent case. The results are illustrated via the age process.

Anderson, Kevin K., and **Krishna B. ATHREYA.** A note on conjugate π-variation and a weak limit theorem for the number of renewals. *Statistics & Probability Letters* 6:3 (1988) 151-154.

A weak limit theorem for the number of renewals N(t) when $1 - F(x)$ is regularly varying with index -1 is given, utilizing an alternate method of constructing conjugates for functions in the well-known subclass π of slowly varying functions. An error in the literature, concerning the centering term when F(x) has a finite mean, is corrected.

Hill, J. H., **T. B. BAILEY,** H. I. Benner, H. Tachibana, and D. P. Durand. Soybean mosaic virus: Effects of primary disease incidence on yield and seed quality. *Plant Disease* 71:3 (1987) 237-239.

Journal Paper No. J-12337 of the Iowa Agriculture and Home Economics Experiment Station, Projects 101, 2475, and 2700.

Various percentages of seedling plants of the soybean cultivar Amsoy 71 were inoculated in a random pattern with soybean mosaic virus (SMV). Seeds harvested from plots, graded for seed-coat mottling, and analyzed for SMV antigen by solid-phase radioimmunoassay showed that levels of virus antigen were positively correlated with disease incidence. Yield reductions were similar in plots where 30 or 50 percent of the plants were inoculated. Experiments in which seed with known antigen levels was used to plant plots showed that antigen levels from seeds harvested from such plots either decreased or increased, depending on the year. It is probable that such results are dependent on the degree of secondary spread and time of inoculation.

Takeda, K., K. J. Frey, and **T. B. BAILEY.** Relationships among traits in F9-derived lines of oats. *Iowa State Journal of Research* 62:2 (1987) 313-327.

Journal Paper No. J-12217 of the Iowa Agriculture and Home Economics Experiment Station, Project 2447.

Linear and nonlinear relationships between grain yield and its components and agronomic traits were studied by utilizing data collected on 1,200 F_9-derived oat lines tested over two years. Grain yield was linearly and positively associated with grain number, but it was independent of seed weight when this trait exceeded 2.3 g/100 seed. Grain yield was positively associated with heading date over the range of 70-77 days, but above 77 the traits were independent. Even though grain yield and plant height were positively associated over the whole range of plant heights, grain yield was constant over that portion of the range between 87 and 102 cm. Grain yield was closely associated with vegetative growth rate, which suggests that this latter trait is important in controlling the yielding potential. The relationship between grain yield and harvest index was curvilinear, with maximum grain yield occurring when harvest index was about 45 percent.

BANCROFT, T. A. and Chien-Pai Han. Pooling data. P. 88-93 in *Encyclopedia of Statistical Sciences, Volume 7: Plackett Family of Distributions—Regression, Wrong*. Samuel Kotz and Norman L. Johnson, editors-in-chief, and Campbell B. Read, associate editor. John Wiley & Sons (New York) 1986.

BANCROFT, T. A. Snedecor, George Waddel. Pp. 526-528 in *Encyclopedia of Statistical Sciences—Volume 8: Regressograms to St. Petersburg Paradox, The*. Samuel Kotz and Norman L. Johnson, editors-in-chief, and Campbell B. Read, executive editor. John Wiley & Sons (New York) 1988.

BATTESE, George E. (Iowa State University and University of New England, Armidale, Australia), and Sohail J. Malik. Estimation of elasticities of substitution for CES production functions using data on selected manufacturing industries in Pakistan. *The Pakistan Development Review* 26:2 (1987) 161-177.

Firm-level stochastic CES (Constant Elasticity of Substitution) production functions are specified for large- and small-scale firms in twelve manufacturing industries in Pakistan. Assuming that firms within specified asset-size categories for which aggregative data are available have the same levels of productive inputs, the elasticities of substitution of labor for capital are estimated, using weighted least-squares regression. For large-scale firms, the estimated elasticities are generally not significantly different from one, whereas for small-scale firms the elasticities are significantly smaller than one but greater than zero.

These results indicate that there may exist more possibilities for the substitution of labor for capital in manufacturing industries in Pakistan than were claimed by earlier researchers. This finding has important policy implications for Pakistan's economic development.

BATTESE, George E., and Sohail J. Malik. Estimation of elasticities of substitution for CES and VES production functions using firm-level data for food-processing industries in Pakistan. *The Pakistan Development Review* 27:1 (1988) 59-71.

Analyses involving CES and VES (Variable Elasticity of Substitution) production functions indicate that the constant-return-to-scale CES model is an adequate representation of large-scale firms in the wheat-flour milling, rice husking, sugar refining, and edible-oil processing industries in Pakistan. The hypothesis that these four food-processing industries have the same elasticities of substitution is not rejected. The pooled elasticity estimate for the food-processing industries is significantly different from zero, but not significantly different from one.

BATTESE, George E. (Iowa State University and University of New England, Armidale, Australia), Rachel M. Harter, and **Wayne A. FULLER.** An error-components model for prediction of county crop areas using survey and satellite data." *Journal of the American Statistical Association* 83:401 (1988) 28-36.

Sample surveys have been designed by the U. S. Department of Agriculture to estimate crop areas for large regions, such as individual states. This article considers prediction of crop areas for small areas such as counties, using satellite data in association with farm-level surveys. Data for 12 Iowa counties, obtained from the 1978 June Enumerative Survey of the U.S. Department of Agriculture, and data obtained from land observatory satellites (LANDSAT) during the 1978 growing season are used. Emphasis is given to predicting the area under corn and soybeans in these counties.

A linear regression model is specified for the relationship between the reported hectares of corn and soybeans within sample segments and the corresponding satellite determination for areas under corn and soybeans. A nested-error model defines a correlation structure among reported crop hectares within the counties. The mean hectares of the crop per segment in a county is defined as the conditional mean of reported hectares, given the satellite determinations and the observed county effect. Variance-component estimators of the parameters of the nested-error model are defined, and the generalized least-squares estimators of the parameters of the linear model are obtained. Predictors of the mean crop hectares per segment are defined in terms of these estimators. An estimator of the variance of the error in the predictor is constructed.

BATTESE, George E., and Tim J. Coelli. Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. *Journal of Econometrics* 38:3 (1988) 387-399.

A stochastic frontier production function is defined for panel data on sample firms, such that the disturbances associated with observations for a given firm involve the differences between traditional symmetric random errors and a non-negative random variable, which is associated with the technical efficiency of the firm. Given that the non-negative firm effects are time-invariant and have a general truncated normal distribution, we obtain the best predictor for the firm-effect random variable and the appropriate technical efficiency of an individual firm, given the values of the disturbances in the model. The results obtained are a generalization of those presented by Jondrow et al. (1982) for a cross-sectional model in which the firm effects have half-normal distribution. The model is applied in the analysis of three years of data for dairy farms in Australia.

Carriquiry, Alicia L., Daniel Gianola, and Rohan L. Fernando. Mixed-model analysis of a censored normal distribution with reference to animal breeding. *Biometrics* 43:4 (1987) 929-939.

A mixed-model procedure for analysis of censored data assuming a multivariate normal distribution is described. A Bayesian framework is adopted that allows for estimation of fixed effects and variance components and prediction of random effects when records are left-censored. The procedure can be extended to right- and two-tailed censoring. The model employed is a generalized linear model, and the estimation equations resemble those arising in analysis of multivariate normal or categorical data with threshold models. Estimates of variance components are obtained using expressions similar to those employed in the EM algorithm for restricted maximum likelihood (REML) estimation under normality.

CRESSIE, Noel. Statistics for spatial data. *Stat Lab News* 1, (1987) 2ff. Statistical Laboratory, Iowa State University (Ames, Iowa).

CRESSIE, Noel. Estimating undercount in the U.S. decennial census. *Bulletin of the International Statistical Institute* 52, Contributed Papers Volume, 85-86, 1987.

An empirical Bayes approach to the estimation of undercount, using weighted squared-error loss, is presented. It is also noted that, by constraining the first two moments of the estimator, the undercount distribution across small areas can be estimated.

CRESSIE, Noel. Comment on "Census undercount adjustment and the quality of geographic population distributions" by Allen L. Schirm and Samuel H. Preston. *Journal of the American Statistical Association* 82:400 (1987) 980-983.

CRESSIE, Noel. Spatial prediction and ordinary kriging. *Mathematical Geology* 20:4 (1988) 405-421.

Suppose data $\{Z(\underline{s}_i): i = 1, \ldots, n\}$ are observed at spatial locations $\{\underline{s}_i: i = 1, \ldots, n\}$. From these data an unknown $Z(\underline{s}_0)$ is to be predicted at a known location $\underline{s}_0$, or, if $Z(\underline{s}_0)$has a component of measurement error, then a smooth version $S(\underline{s}_0)$ should be predicted. This article considers the assumptions needed to carry out the spatial prediction using ordinary kriging, and looks at how nugget effect, range, and sill of the variogram affect the predictor. It is concluded that certain commonly held interpretations of these variogram parameters should be modified.

CRESSIE, Noel, and G. M. Laslett. Random set theory and problems of modeling. *SIAM Review* 29:4 (1987) 557-574.

The three- or four-dimensional world in which we live is full of objects to be measured and summarized. Very often a parsimonious finite collection of measurements is enough for scientific investigation into an object's genesis and evolution. There is a growing need, however, to describe and model objects through their form as well as their size. The purpose of this article is to show the potentials and limitations of a probabilistic and statistical approach. Collections of objects (the data) are assimilated to a random set (the model), whose parameters provide description and/or explanation. Data are analyzed and random-set parameters are estimated.

CRESSIE, Noel, and Peter B. Morgan. The VPRT: Optimal sequential and nonsequential testing. Pp. 107-118 in *Statistical Decision Theory and Related Topics IV,* Volume 2, edited by S. S. Gupta and J. O. Berger. Springer-Verlag (New York) 1988.

Under assumptions of variable cost function, finite truncation time, discounting, and variable sample size at each time point, a Bayes sequential procedure called the VPRT (variable-sample-size-sequential probability ratio test) is constructed. The VPRT procedure also minimizes expected total sampling cost. A computer program that computes the

optimal sampling plan, the probabilities of type I and type II errors, the expected stopping time, the expected total sampling cost, etc., allows a numerical comparison to be made to various suboptimal sequential procedures, such as one-at-a-time sampling, and the group-sequential procedure.

CRESSIE, N. A. C., and P. D. Shaughnessy. *Marine Mammal Science* 3:4 (1987) 297-307.

The Cape fur seal *Arctocephalus pusillus* of South Africa and Namibia breeds in 23 colonies. Aerial surveys have been used to estimate numbers of pups during breeding seasons from December 1971 to December 1978, and the results have been presented by Shaughnessy (1987). In this paper we develop statistical methods for estimating those pup numbers, as well as variances of the estimates. We demonstrate a significant increase in numbers of seal pups between 1971 and 1976; the rate of increase is estimated to be 3.2 percent per annum.

Crowder, Stephen V. (ISU and Corning Glass Company), **Karen L. Jensen, W. Robert STEPHENSON,** and **Stephen B. VARDEMAN.** An interactive program for the analysis of data from two-level factorial experiments via probability plotting. *Journal of Quality Technology* 20:2 (1988) 140-148.

An interactive computer program is presented that expedites the analysis for unreplicated two-level factorial and fractional factorial experimental designs advocated by C. Daniel [*Applications of Statistics to Industrial Experimentation,* John Wiley & Sons, New York, NY (1976)] and G. E. P. Box, W. G. Hunter, and J. S. Hunter [*Statistics for Experimenters,* Wiley (1978)]. The program calculates estimated effects via the Yates algorithm, identifies statistically detectable effects via normal plots and half normal plots, fits candidate models via the reverse Yates algorithm, and enables evaluation of candidate models through residual plots. The program can handle the analysis of standard 2^{p-q} fractional factorial experiments where $p - q \leqq 7$ and can be modified to allow $p - q > 7$.

DAVID, H. T. Bayes extraction of component failure information from Boolean module test data. *Communications in Statistics (Special Issue on Factor Screening)* 16:10 (1987) 2873-2883.

A Bayesian approach allows inferring component reliability from module test data.

Francisco, Carol A. (Iowa State University and Syntex Laboratories), **Wayne A. FULLER,** and Ron Fecso. Statistical properties of crop production estimators. *Survey Methodology* 13:1 (1987) 45-62.

The National Agricultural Statistics Service, U.S. Department of Agriculture, conducts yield surveys for a variety of field crops in the United States. While field sampling procedures for various crops differ, the same basic survey design is used for all crops. The survey design and current estimators are reviewed. Alternative estimators of yield and production and of the variance of the estimators are presented. Current estimators and alternative estimators are compared, both theoretically and in a Monte Carlo simulation.

Labuschagne, B. C. J., T. D. Wheelock, **R. K. Guo, H. T. DAVID,** and R. Markuszewski. Moisture content as predictor of coal hydrophobicity. Pp. 415-425 in *Proceedings of the 13th International Conference on Coal and Slurry Technology,* held in Denver, Colorado, April 12-15, 1988. The Coal and Slurry Technology Association, Washington, D.C. 1988.

A statistical analysis of previously published experimental data shows that coal hydrophobicity correlates better with moisture content than with carbon content, as measured by the Spearman rank correlation coefficient in ranges where both relations are monotone, and by R_2 about quadratic regression when they are not.

Kroger, Jane, and **Stephen J. HASLETT.** Separation-individuation and ego identity status in late adolescence: A two-year longitudinal study. *Journal of Youth and Adolescence* 17:1 (1988) 59-79.

Separation-individuation or attachment style (secure/not secure) and ego identity status (achieved, moratorium, foreclosed, and diffused) are two theoretical constructs used to clarify developmental relationships. A total of 76 subjects (41 females, 35 males) who were given the Marcia Ego Identity Status Interview and the Hapsburg Separation Anxiety Test (SAT) as first year students at Victoria University, New Zealand, in 1984, were reassessed two years later. Loglinear models were used in the analysis of the sparse data, which indicated that there were strong links between attachment style and identity status in 1986, and between identity statuses in 1984 and 1986.

Wear, Robert G., and **Stephen J. HASLETT.** Studies on the biology and ecology of *Artemia* from Lake Grassmere, New Zealand. Pp. 101-126 in *Artemia Research and Its Applications—Vol. 3: Ecology, Culturing, Use in Aquaculture.* P. Sorgeloos, D. A. Bengtson, W. Decleir, and E. Jaspers, editors. Universa Press (Wetteren, Belgium). 1987.

During 1981-83 the biology of *Artemia franciscana* from the solar salt ponds of Lake Grassmere (Marlborough, New Zealand) was studied in the laboratory, and a field sampling program to estimate biomass was carried out over 18 months including two southern summers. *Artemia* densities were highest in 13 final concentrating ponds 238.5 ha in total area, and were contagiously distributed over two strata; i.e., the 50 m wide edge stratum averaged 2.5 times the biomass concentration of the central stratum. A statistically unbiased estimate of biomass was developed for each bimonthly sampling, giving asym-

metric 95 percent confidence bound estimates, based on the bootstrap method, each within 25 percent of the estimated total *Artemia* biomass in sampled ponds. Maximum estimated total biomass for any sampling time over 238.5 ha was 12 tonnes dry weight, and was highest during late spring and summer. In one of the 13 ponds, estimated biomass concentration from November 1981 to April 1982 averaged 4.9.g/m^3 dry weight. Between November 1983 and May 1984, 4.2 g/m^3 dry weight *Artemia* were recovered by total filtration from the adjacent pond.

Harvestable biomass over the pond system was conservatively estimated at about 35 tonnes dry weight per year and could be extracted without affecting standing biomass, regenerative capability, or salt production. This estimate took into account field nutrient levels, pond algal densities, and algal growth rates achieved in the laboratory, as well as laboratory studies on *Artemia* growth, mortality, longevity, generation times, and fecundity carried out in 24 replicated combinations of temperature (8-32°C) and salinity (80-260 ‰). The two factors, temperature and salinity, accounted for 81.3 percent and 87.9 percent of the total sums of squares for growth and percentage juvenile survivorship, respectively, with temperature the major determinant in both cases. *Artemia* achieved fastest growth at 20-28°C in 100-170 ‰ salinity. Over this range at least 90 percent of the nauplii survived to maturity, which was achieved in 10 to 20 days; generation times were 14 to 20 days; and individuals lived for up to 6 months. The average number of generations per year was estimated to be seven.

Wear, Robert G., and **Stephen J. HASLETT.** A minimal strategy for assessing *Artemia* biomass harvestable from production salinas. Pp. 217-220 in *Artemia Research and Its Applications—Vol. 3: Ecology, Culturing, Use in Aquaculture*. P. Sorgeloos, D. A. Bengtson, W. Decleir, and E. Jaspers, editors. Univers Press (Wetteren, Belgium). 1987.

It is likely that *Artemia* biomass will in future years become increasingly important as a feed or feed supplement in aquaculture systems. However, our knowledge of the ecology and population dynamics of *Artemia* in natural habitats is incomplete, and any meaningful study requires very detailed consideration of the many complex interactions involved (Haslett and Wear, 1985; Wear and Haslett, 1986, 1987; Wear *et al.*, 1986). Assessing *Artemia* biomass harvestable on a renewable basis from solar salt production ponds, or determining total allowable catch of *Artemia* in the context of fisheries management, does not require such sophistication. Since *Artemia* plays an important part in maintaining a healthy biological balance in commercial salinas, any overexploitation may reduce grazing pressure on unicellular algal blooms and may also in turn deleteriously affect the quantity and quality of solar salt produced.

The principles outlined provide a minimal program necessary to plan and maintain an economic harvest of *Artemia* biomass without placing salt production at risk. Site-specific modifications may be appropriate.

HINZ, P. N. Nearest-neighbor analysis in practice. *Iowa State Journal of Research*. 62:2 (1987) 199-217.

The practical application of nearest-neighbor analysis is demonstrated by using the technique to analyze four different sets of data. For these data, the standard methodology of removing row and column variation as classification variables is equally effective and sometimes superior to the nearest-neighbor analysis.

Sieber, M., A. E. Freeman, and **P. N. HINZ.** Factor analysis for evaluating relationships between first lactation type scores and production data of Holstein dairy cows. *Journal of Dairy Science* 70:5 (1987) 1018-1026.

Journal Paper No. J-12359 of the Iowa Agriculture and Home Economics Experiment Station, Project 1053.

Data on linear type scores for 18 traits and production records of 43,428 Holstein cows were analyzed by use of factor analysis and multiple regression. A principal factor analysis defined 8 factors from the type scores. Factor scores were used as independent variables in a multiple regression to explain production variables. Herdmate deviation milk and fat were found to be more closely related to characteristics of the mammary system than they are to body characteristics. For herdlife analysis, cows with well attached udders stayed in herds longer.

Sieber, M., A. E. Freeman, and **P. N. HINZ.** Comparison between factor analysis from a phenotypic and genetic correlation matrix using linear type traits of Holstein dairy cows. *Journal of Dairy Science* 71:2 (1988) 477-484.

Journal Paper No. J-12707 of the Iowa Agriculture and Home Economics Experiment Station, Project 1053.

Data on 18 linear type scores and production data for 43,428 records were used to compare factor analysis procedures using a genetic correlation matrix versus using a phenotypic correlation matrix.

Marcy, J. A., A. A. Kraft, **D. K. HOTCHKISS,** R. A. Molins, D. G. Olson, H. W. Walker, and P. J. White. Effect of acid and alkaline pyrophosphate blends on the natural flora of a cooked meat system. *Journal of Food Science* 53:1 (1988) 25-27.

Journal Paper No. J-12538 of the Iowa Agriculture and Home Economics Experiment Station, Project 2252.

The objective of the investigation was to demonstrate that differences in the antimicrobial action of two specific pyrophosphates in cooked meat were independent of the number of phosphorous atoms present and then, if the two phosphates exhibited a

synergistic effect when used in combination, to determine their optimum ratio. A completely randomized design with five replications was used, with 6 serial combinations of the two phosphates and 6 refrigerated storage times. Samples, with four replications, were also stored at room temperature (20-22°C) for 24 and 48 hours (temperature abuse) and then placed in refrigerated storage.

It was determined that neither phosphate had an effect on microbial counts during refrigerated storage up to 21 days, but sodium acid pyrophosphate caused significantly lower counts of mesophilic and facultative anaerobic organisms after 48 hours of temperature abuse.

Marcy, J. A., A. A. Kraft, **D. K. HOTCHKISS,** R. A. Molins, D. G. Olson, H. W. Walker, and P. J. White. Effect of acid and neutral pyrophosphates on the natural bacterial flora of a cooked meat system. *Journal of Food Science* 53:1 (1988) 28-30.

Journal Paper No. J-12650 of the Iowa Agriculture and Home Economics Experiment Station, Project 2252.

The objective of this investigation was to compare sodium acid pyrophosphate (SAPP), a compound with known antimicrobial activity and used in processing meat products, with trisodium pyrophosphate (PYRO-3), a neutral pyrophosphate used in meat products in Germany but not yet evaluated in terms of antimicrobial properties in meat. The microbial effects of the selected pyrophosphates were studied in cooked, vacuum-packaged pork sausage stored at 7°C for 21 days, or at 20-22°C for 24 and 48 hours. PYRO-3 and SAPP were tested at 0 and 0.4 percent meat weight, separately or in combinations. A design similar to the one described in the preceding abstract was used, with five replications for refrigerated storage and room temperature storage.

Evaluation of results indicated that both phosphates had an effect after 21 days of refrigerated storage (7°C), with lower mesophilic counts than controls with no phosphate added. Both phosphates also resulted in significantly lower counts of mesophilic and facultative anaerobic microorganisms in sausage after 48 hours of temperature abuse (20-22°C). The organisms affected were mainly streptococci.

Marcy, J. A., A. A. Kraft, **D. K. HOTCHKISS,** R. A. Molins, D. G. Olson, H. W. Walker, and K. Merkenich. Effects of selected commercial phosphate products on the natural bacterial flora of a cooked meat system. *Journal of Food Science* 53:2 (1988) 391-393 and 577.

Journal Paper No. J-12651 of the Iowa Agriculture and Home Economics Experiment Station, Project 2252.

The objectives of this work were twofold: to compare the potential antibacterial activity of selected phosphate blends and a neutral pyrophosphate in sausage, and to determine whether potential bacterial inhibition by phosphates is at present being limited by the 0.5 percent maximum level imposed on meat products. Four commercial phosphate blends and a neutral pyrophosphate were used at three levels (0.30-0.65 percent) in the preparation of cooked sausage. Control treatments contained no phosphate. Vacuum-packaged sausage was stored at 5°C for 21 days or held at room temperature (20-22°C) for up to 48 hours after 7 days of refrigerated storage.

Mesophilic and facultative anaerobic bacterial counts were highest in control treatments after 14 and 21 days at 5°C and after 24 and 48 hours at 20-22°C. For each phosphate, the level of addition was the determining factor in bacterial inhibition, since the highest phosphate level resulted in the lowest bacterial counts in sausage held at 5°C and 20-22°C. The level of phosphate was more important than the type of phosphate was in prolonging shelf life.

Reece, W. O., and **D. K. HOTCHKISS.** Blood studies and performance among calves reared by different methods. *Journal of Dairy Science* 70:8 (1987) 1601-1611.

A major issue to be resolved between commercial veal producers and animal welfare advocates is the matter of stall confinement versus freedom of movement. Quantitative physiological measurements to determine baseline values for food animals in various management systems need to be developed and validated. In the present research, three methods of feeding calves were compared as follows: (1) milk replacer only with restricted movement, (2) milk replacer only with freedom of movement, and (3) hay, grain, and water with freedom of movement. Data were analyzed as a split-plot experiment where the calf was the whole plot unit for testing treatment effects, and time was the subplot effect measured within each calf. No significant differences were noted for variables of acid-base balance. A serum iron deficiency developed in the calves receiving milk replacer only. Average daily gain, carcass grade, and sale price were superior for calves receiving only milk replacer with freedom of movement as compared with those with restricted movement.

A fourth method of feeding (calves nursing cows), represented by calves having a different origin, was compared as a supplemental group. Absolute numbers for lymphocytes and neutrophils were significantly higher for calves nursing cows than for calves reared by the other methods.

Reece, W. O., Gene H. Rouse, and **Donald K. HOTCHKISS.** Erythrocyte and serum iron studies of cows and their calves following iron injection in the cows during late pregnancy. *Beef Cattle Research Report.* Department of Animal Science, Iowa State University. January 1987. A. S. Leaflet R472. Pp. 237-243.

The objective of the present research was to study the responses of the red blood cell variables and serum iron concentrations in cows and their calves resulting from the injection of iron into cows during

their third trimester of pregnancy. Both sets of data (cow and calf) were analyzed as a split-plot experiment with iron injection as the whole-plot treatment and time before (or after) calving as the subplot treatment.

The data from this experiment suggest that Fe injected into cows during late pregnancy is primarily directed to the fetus for storage as reserve Fe for use after birth when calves' Fe intake is minimal. The data also suggest that erythropoiesis in the cows may be curtailed during late pregnancy so that maximum Fe can be diverted to the fetus.

Hung, Hsien-Ming (Wichita State University) and **Wayne A. FULLER.** Regression estimation of crop acreages with transformed Landsat data as auxiliary variables. *Journal of Business & Economic Statistics* 5:4 (1987) 475-482.

Methods are developed for combining data collected by satellite with data collected in an area survey to estimate crop acreages. The basic procedure is that of survey regression estimation. Two methods of transforming the satellite information prior to regression estimation are compared.

Johnson, Jean, and **Dean ISAACSON.** Conditions for strong ergodicity using intensity matrices. *Journal of Applied Probability* 25:1 (1988) 34-42.

Sufficient conditions for strong ergodicity of discrete-time nonhomogeneous Markov chains have been given in several papers. Conditions have been given using the left eigenvectors ψ_n of $P_n(\psi_n P_n = \psi_n)$ and also using the limiting behavior of P_n. In this paper we consider the analogous results in the case of continuous-time Markov chains where one uses the intensity matrices $Q(t)$ instead of $P(s,t)$. A bound on the rate of convergence of certain strongly ergodic chains is also given.

Jeske, Daniel R. (Iowa State University and AT&T Bell Laboratories), and **David A. HARVILLE.** Prediction-interval procedures and (fixed-effects) confidence-interval procedures for mixed linear models. *Communications in Statistics (Theory and Methods)* 17:4 (1988) 1053-1087.

A general approach is presented for devising an approximate $100(1-\alpha)$ percent prediction interval for an unobservable random variable w based on the value of an observable random vector y. It is assumed that E(w) and E(y) are linear combinations of unknown parameters $\beta_1, \beta_2, \ldots, \beta_p$ and that the joint distribution of $w-E(w)$ and $Y-E(y)$ is symmetric and known up to the value of a vector θ of unknown parameters. This would be the case if y followed a mixed linear model (with normally distributed random effects and errors) and w were a linear combination of the model's fixed and random effects. Various implementations of the proposed approach are illustrated, and comparisons among them made, in the context of the Behrens-Fisher problem and the problem of making inferences about a group mean under a balanced one-way random-effects model.

Bendre, S. M., and **B. K. KALE** (University of Poona, India). Masking effect on tests for outliers in normal samples. *Biometrika* 74:4 (1987) 891-896.

Bendre and Kale [*Journal of the American Statistical Association* 80 (1985) 1020-1025] defined a simple measure of the masking effect on tests for outliers as the loss in power due to the presence of more than the number of outliers under test. The present paper uses the same measure to investigate the limiting masking effects on outlier tests such as the Grubbs, Ferguson, and Dixon tests. Ferguson's test based on sample skewness is more robust against the masking effect than the others.

KEMPTHORNE, Oscar. Randomization—II. Pp. 519-524 in *Encyclopedia of Statistical Sciences, Volume 7: Plackett Family of Distributions—Regression, Wrong*. Samuel Kotz and Norman L. Johnson, editors-in-chief, and Campbell B. Read, associate editor. John Wiley & Sons (New York) 1986.

Journal Paper No. J-11257 of the Iowa Agriculture and Home Economics Experiment Station, Project 890.

KEMPTHORNE, Oscar. The impact of cross-disciplinary activity in statistics and agriculture. *Statistician's Productivity and Quality Record*—Newsletter of the American Statistical Association's Quality and Productivity Committee 1:3 (1987) 6-11.

The paper presents a challenge to researchers in quality and productivity to become emotionally involved in the problems of the engineer. The role of statistical cross-disciplinary thinking and interaction in research and development in agriculture is discussed. Implications with regard to engineering research and development are pointed out.

KEMPTHORNE, Oscar. Discussion: "What is an analysis of variance?" by T. P. Speed. *The Annals of Statistics* 15:3 (1987) 925-929.

Stone, Janis F., Marilyn L. Eichner, Charles Kim, and **Kenneth KOEHLER.** Relationships between clothing and pesticide poisoning—symptoms among Iowa farmers. *Journal of Environmental Health* 50:4 (1988) 210-215.

Clothing worn for farm pesticide application and reports of experience with pesticide poisoning symptoms were studied through a survey using a sample of 1200 private pesticide applicators in Iowa. A 61 percent return rate was obtained and showed that farm applicators did not vary their clothing according to the toxicity of the chemicals being used. The majority of farm applicators wore jeans, long-sleeved shirts, leather boots, undershorts, socks, and a company/baseball type hat to apply pesticides. Waterproof gloves were worn by 30 percent. About one fourth of the farmers said they had never experienced any poisoning symptoms, but 43 percent had experienced 1 to 4 symptoms and 30 percent had experienced 5 to 18 symptoms associated with pesticide exposures.

Statistically significant relationships were found between the symptom score (number of symptoms experienced) and the toxicity of the insecticide and herbicide that most frequently gets on clothes, the pesticide that gets through clothing to the skin, and the fiber content of the clothes. Symptom score also was significantly related to the age of the applicator and to the number of weeks spent in application each year. Additional research and educational programs are indicated to minimize pesticide exposure.

LORENZ, Frederick O. Community opinions affecting the survival of rural regional councils. Pp. 105-112 in *Perspectives on Small City Planning and Policy Making: Readings and Commentary.* Gary Mattson, editor. Ginn Press (Lexington, Massachusetts). 1987.

Rural regional councils and planning agencies have declined in recent years, due to declining federal support. However, survival among the agencies is better where there has historically been strong local support for regional councils as intergoverning coordinating organizations.

LORENZ, Frederick, and David L. Rogers. Impact of Federal grants on local government capacity. Pp. 99-120 in *Policy Evaluation for Local Governments.* Terry L. Busson and Phillip Coulter, editors. Kennikat (Port Washington, New York). 1988.

Federal government attempts to strengthen local government capacity to effectively manage and coordinate resources have suffered from "strong claims and weak effects." Federal grants have had their most direct effect on the ability of local governments to do planning, but have had little measurable effect on managerial or technical ability.

Escobar, L. A., and **W. Q. MEEKER.** Using the SAS* system to assess local influence in regression analysis with censored data. *Proceedings of the Thirteenth Annual SAS Users Group International Conference.* SAS Institute, Inc., Cary, North Carolina (1988) 1036-1041.

Inferences in survival data analysis are frequently based on a parametric regression model. Sometimes we have empirical evidence or subject matter knowledge that the assumed model will provide an adequate approximation to make inferences. Most commonly, we have very little information on the validity of the assumptions and we need to assess the impact of possible model departures on the inferences. This can be done using "global" and "local" measures of influence. R. D. Cook [*Journal of the Royal Statistical Society B* 48 (1986) 133-169] discusses the differences between these two types of influence measures and develops general theory for local influence analysis. L. A. Escobar and W. Q. Meeker [Statistical Laboratory Preprint Series #88-15, Iowa State University, Ames, Iowa (1988) 42 pp.] give detailed information on the application of Cook's methodology to regression analysis with arbitrarily censored data.

This paper describes a SAS* macro for the assessing local influence in regression analysis with censored data. The macro allows one to identify those observations that have the greatest local influence on the estimates of the parameters or functions of the parameters of one's model.

*SAS is a registered trademark of SAS Institute, Inc.

Ostrouchov, George, and **William Q. MEEKER, Jr.** . Accuracy of approximate confidence bounds computed from interval censored Weibull and lognormal data. *Journal of Statistical Computation and Simulation* 29:1 (1988) 43-76.

Interval censored data arise frequently in industrial life tests and other applications. Maximum likelihood estimation provides a convenient means for making inferences on important distribution properties like quantiles and failure probabilities. The asymptotic normal distribution of the maximum likelihood estimators provides a simple method of setting approximate confidence bounds on these quantiles. Inverting likelihood ratio tests is another alternative.

This paper uses Monte Carlo simulation to investigate the finite sample properties of maximum likelihood estimators of Weibull and lognormal parameters and quantiles from interval censored data. We evaluate the accuracy of large sample one- and two-sided confidence bounds based on asymptotic normal theory and compare their accuracy (with respect to coverage probability) to those obtained by inverting likelihood ratio tests. Even though these procedures are asymptotically equivalent, our results show that the intervals based on inverting a likelihood ratio test generally have coverage properties that are closer to the nominal confidence levels.

POLLAK, Edward. On the theory of partially inbreeding finite populations. I. Partial selfing. *Genetics* 117:2 (1987) 353-360.

Journal Paper No. J-12528 of the Iowa Agriculture and Home Economics Experiment Station, Project 2588.

Some stochastic theory is developed for monoecious populations of size N in which there are probabilities β and $1 - \beta$ of reproduction by selfing and by random mating. It is assumed that $\beta >> N^{-1}$. Expressions are derived for the inbreeding coefficient of one random individual and the coefficient of kinship of two random separate individuals at time t. The mean and between-lines variance of the fraction of copies of a gene that are identical in two random separate individuals in an equilibrium population are obtained under the assumption that there is an infinite number of possible alleles.

It is found that the theory for random mating populations holds if the effective population number is $N_e = N'/(1 + F_{IS})$, where F_{IS} is the inbreeding coefficient at equilibrium when N is infinite and N′ is

the reciprocal of the probability that two gametes contributing to random separate adults come from the same parent. When there is a binomial distribution of successful gametes emanating from each adult, $N' = N$. An approximation to the probability that an allele A survives if it is originally present in one $A\bar{A}$ heterozygote is found to be $2(N'/N)(F_{IS}s_1 + (1 - F_{IS})s_2)$, where s_1 and s_2 are the selective advantages of AA and $A\bar{A}$ in comparison with $\bar{A}\bar{A}$. In the last section it is shown that, if there is partial full sib mating and binomial offspring distributions, $N_e = N/(1 + 3F_{IS})$.

Beavis, W. D., **E. POLLAK,** and K. J. Frey. A theoretical model for quantitatively inherited traits influenced by nuclear-cytoplasmic interactions. *Theoretical and Applied Genetics* 74:5 (1987) 571-578.

Journal Paper No. J-12457 of the Iowa Agriculture and Home Economics Experiment Station, Project 2447.

Cytoplasmic genes of crop species exhibit non-Mendelian inheritance and affect quantitative traits such as biomass and grain yield. Photosynthesis and respiration are physiological processes responsible, in part, for the expression of such quantitative traits and are regulated by enzymes encoded in both the cytoplasm and the nucleus. Cytoplasmic genes are located in the chloroplast and mitochondrial genomes. Unlike the nuclear genome, the cytoplasmic genomes consist of single, circular, double-stranded molecules of DNA and, in many crop species, the cytoplasmic genomes are inherited solely through the maternal parent. Maternal inheritance of cytoplasmic genomes and Mendelian inheritance of the nuclear genome were used to model the genotypic value of an individual. The model then was utilized to derive genetic variances and covariances for a random-mating population. Finally, the use of reciprocal mating designs to estimate variance components was investigated.

ROBERTS, Carl W., Richard Green, Katherine Williams, and Marilyn Goodman. Boyhood gender identity development: A statistical contrast of two family groups. *Developmental Psychology* 23:4 (1987) 544- 557.

The genesis of boyhood cross-gender behaviors is analyzed by comparing cross-sectional data on families of boys with extensive cross-gender behavior with data on families of boys with more masculine behaviors. A measure of extent of boyhood femininity is developed by discriminating these two groups according to measures of each boy's sex-typed behaviors. Two methods are used in evaluating the explanatory value of variables hypothesized as affecting boyhood gender identity: (a) Between-group differences on these variables clarify potential sources of atypical gender identity in males; (b) Within-group correlations between these variables and extent of boyhood femininity yield information on similarities and differences in the origins of boyhood cross-gender behaviors for each group.

No definite support is found for either modeling or social learning theories of gender identity development. However, striking differences in within-group correlations between the two family groups suggest a qualitative difference in the processes that produce gender identity among boys with typical versus atypical amounts of cross-gender behavior.

Green, R., **C. W. ROBERTS,** K. Williams, M. Goodman, and A. M. Mixon. Specific cross-gender behaviour in boyhood and later homosexual orientation. *British Journal of Psychiatry* 15 (1987) 84-88.

An analysis was performed on follow-up data from a group of males aged 13 to 23, who as children exhibited extensive cross-gender behavior. Each boy had previously been evaluated before age 12 in a matched-comparison study. The majority of this group had evolved a bisexual or homosexual orientation at the time of the follow-up. Two types of previous cross-gender behavior, boyhood doll play and female role-playing, were found to be significantly associated with later homosexual orientation. The findings suggest developmental associations between specific types of boyhood cross-gender behavior and the objects of later sexual arousal.

SACKS, J. M., K. G. Gillette, and G. H. Frank. Development and evaluation of an enzyme-linked immunosorbent assay for bovine antibody to *Pasteurella haemolytica:* Constructing an enzyme-linked immunosorbent assay titer. *American Journal of Veterinary Research* 49:1 (1988) 38-41.

A two-stage strategy for estimating serum antibody titer by enzyme-linked immunosorbent assay dilution assays was developed and evaluated. In stage one, the linear response region and least-square estimate of the assay line slope were established from 9-point dilution assays. This information is used in stage-two estimation of titer from a single absorbance reading, providing the reading is within the linear response region. Operationally, two fixed dilutions were selected, one suitably low and one suitably high, to provide at least one reading in the linear region. The procedure should save considerable time when many assays are scheduled. Stage one requires approximately twenty 9-point assays, and all future assays require only two fixed dilutions.

Bolin, Steven R., **Jerome M. SACKS,** and **Stephen V. Crowder** (Corning Glass Works). Frequency of association of noncytopathic bovine viral diarrhea virus with mononuclear leukocytes from persistently infected cattle. *American Journal of Veterinary Research* 48:10 (1987) 1441-1445.

The purpose of the study was to determine the percentage of mononuclear leukocytes associated with noncytopathic BVD virus in persistently infected cattle and to determine whether noncytopathic BVD virus was associated with T lymphocyte- and/or B lymphocyte-enriched subpopulations of mononuclear leukocytes. Eight cows persistently infected

with one of three isolates of noncytopathic bovine viral diarrhea virus were used as blood donors. All mononuclear leukocytes and T lymphocyte-enriched and B lymphocyte-enriched subpopulations in the blood sample collections were tested for association with the virus. Approximately 4.4 percent of all mononuclear leukocytes, 5.4 percent of the T lymphocyte-enriched subpopulation, and 2.1 percent of the B lymphocyte-enriched subpopulation were associated with virus. Differences between leukocyte populations in percentages of leukocytes associated with virus were statistically significant ($P < 0.05$). However, among virus isolates significant differences were not detected in rates of viral association with mononuclear leukocytes. Implications for further research are discussed.

Peden, W. M., J. L. Richard, J. R. Thurston, and **J. M. SACKS.** Effects of pre-treatment with aflatoxin on a second aflatoxin treatment in guinea pigs. *Mycopathologia* 99:2 (1987) 107-114.

Two hundred guinea pigs, weighing approximately 500 grams each, were placed in eight groups, four of which received 20 μg/kg/day of partially purified aflatoxin for 7 days, followed by a 7-day recovery period. Paired groups then received 0, 20, 35, or 50 μg/kg/day of partially purified aflatoxin for 21 days. Animals were sacrificed periodically from all groups, and blood was drawn for chemical and immunologic analyses. Weight gains were recorded and histopathologic studies were done on all animals.

Pretreatment did not protect guinea pigs from a second exposure, and in fact enhanced mortality and liver toxicity as determined by histopathology. Serum chemistries and immunologic parameters of guinea pigs dosed twice were less conclusive, as neither high nor low doses produced results that differed from those in guinea pigs treated once. Glycocholic acid concentrations were more sensitive than traditional enzymes (aspartate and alanine amino transferase, alkaline phosphatase) for indicating hepatotoxicity.

Scott, Margaret E. (Indiana State University), **Dan M. SCOTT** (Rose-Hulman Institute of Technology), and **Edward POLLAK.** Conditions under which the mean fertility is maximized when a population is at a stable equilibrium. *Genetics* 118:4 (1988) 713-720.

Journal Paper No. J-12411 of the Iowa Agriculture and Home Economics Experiment Station, Project 2588.

It is assumed that there is a population with two alleles at one locus, random mating of adults and selection only involving differential fertilities. By making use of the Kuhn-Tucker theory of optimization under constraints, conditions are derived under which stable equilibrium frequencies x, y, and z of the three genotypes are the same as those that maximize the mean fertility of the population.

We derive all sets of frequencies of this type for the Hadeler-Liberman symmetric fertility model and all such sets for which at least one genotype is missing for the general model. If the population has frequencies that are initially near those at which there is both a stable equilibrium and maximization of the mean fertility, then the mean fertility ϕ_t at time t is nondecreasing with t as $t \to \infty$. It is found that it is possible for the stable equilibrium maximum points (x, y, z) to be one or two points on a ridge on which the mean fertility ϕ is maximized or the entire set of points on the ridge. Furthermore, ϕ may be smaller on this ridge than at another stable equilibrium point at which ϕ is not even locally maximized.

Stone, Janis, and **Mack SHELLEY.** Iowa farmers' attitudes about pesticides and clothing: Perception of risk, benefit, and safety practices. *Proceedings of the First International Symposium on the Impact of Pesticides, Industrial, and Consumer Chemicals in the Near Environment,* sponsored by USDA-CSRS and University of Georgia. Kansas State University (1988) 243-254.

The purpose of this study was to investigate the attitudes of Iowa farm pesticide applicators regarding perceived risks, benefits, and expectations regarding pesticide use and safety recommendations. Based on 638 usable responses to a 1984 survey of Iowa registered pesticide applicators, a factor analysis revealed the presence of four primary attitude dimensions, which were further tested for reliability.

SPOSITO, V. A. On median polish and L_1 estimators. *Computational Statistics & Data Analysis* 5:3 (1987) 155-162.

Recent research has addressed different facets of an iterative procedure called median polish. The question of verifying whether any median polish fit is also an L_1 solution, i.e., a solution that also minimizes the sum of absolute deviations, has not been addressed in the recent literature. This note will show that well-known results can be used to verify that equivalence.

STEPHENSON, W. Robert, and **David Jacobson** (ISU; IBM Corporation). A comparison of nonparametric analysis of covariance techniques. *Communications in Statistics—Simulation and Computation* B17:2 (1988) 451-461.

A small sample Monte Carlo simulation provides the means of comparison for several nonparametric alternatives to the standard analysis of covariance. A completely randomized design with samples from K populations and one covariate is used for this study. The simulation evaluates the robustness of the techniques as well as the power to detect differences among the populations. The study indicates that a modification of existing nonparametric procedures yields a test that performs well in many situations.

STRAHAN, Robert. Measures of consistency for Holland-type codes. *Journal of Vocational Behavior* 31:1 (1987) 37-44.

"Consistency" in John Holland's theory of vocational preference refers to the extent to which more closely related scale types are found together in codes of the Self-Directed Search sort. This paper describes two new measures of consistency. One is based on the theoretical hexagonal model and is for use with 3-point codes. The other is based on conditional probabilities and is for use with 2-point codes.

STRAHAN, Robert F. Student preference for second chance course examinations. *Network* 5:3 (1987) 8- 10.

de Haan, L., and **I. WEISSMAN** (Technion, Haifa, Israel). The index of the outstanding observation among n independent ones. *Stochastic Processes and Their Applications* 27 (1988) 317-329.

Let $X_1,X_2, \ldots$ be independent random variables with distribution functions $F_1,F_2, \ldots$ respectively, $M_n = \max\{X_1, \ldots ,X_n\}$ and $L_n = \min\{k \leqq n: X_k = M_n\}$. Assume that there exist constants $a_n > 0$ and b_n such that $(M_n - b_n)/a_n$ converges in distribution to a nondegenerate random variable. It is easy to show that if for all t in (0,1) $(M_{[nt]} - b_n)/a_n$ converges in distribution, so does L_n/n. We study the converse problem, namely, is it true that the convergence of L_n/n to a nondegenerate random variable implies the convergence in distribution of $(M_{[nt]} - b_n)a_n$ for all $t \varepsilon (0,1)$?

White, S. E., T. S. Colvin, and **J. SACKS.** Evaluation of a soil moisture model. Pp. 61-70 in the *Proceedings of the 3rd International Workshop on Land Drainage* (1987), Ohio State University.

An evaluation was made of a simulation model designed to predict available field operation time. The simulation model was based on the premise that workable field days could be accurately predicted if a field's tractability condition was known. The model determined a field's tractability condition as "good" or "bad" using local soil characteristics and daily weather factors. A model such as this may be useful worldwide for operational planning of time and machinery systems. The model was judged to work reasonably well in an analysis of four environmentally different regions in the midwest. However, further investigation is needed to determine the extent of the model's applicability.

WOLINS, Leroy. Science and rationality. *Behavioral and Brain Science* 10:4 (1987) 617.

Lundholm, Jean K., and **Leroy WOLINS.** Disordered eating and weight control behaviors among male and female university students. *Addictive Behaviors* 12:3 (1987) 275-279.

The purposes of this study were to develop an instrument capable of assessing factors potentially related to disordered eating and weight control behaviors among university students and then to compare male and female students on these factors.

A 90-item instrument was developed. Sixty-four items were written by these authors, such that eight items would assess each of eight identified factors related to disordered eating. Additionally, all 26 items from the Eating Attitudes Test (EAT-26) were included and interspersed within the instrument. The instrument was administered to 502 female university students, and their responses were factor analyzed. Ten factors were identified. The instrument was then administered to 94 female and 76 male university students.

Results indicate that, compared to males, females report a greater desire to be thin, less tolerance for cold, more frequent use of laxatives, and a greater occurrence of eating in response to internal and external cues. There were no other sex differences. The students in this study appeared to be engaging in appropriate health practices.

Book Reviews, Etcetera

BATTESE, George E. *Applied Statistical Analyses,* by S. R. Harrison and H. U. Tamaschke (Prentice-Hall, Sydney, 1984), 547 pp. Reviewed in *Australian Journal of Agricultural Economics,* 31 (1987) 91-94.

CRESSIE, Noel. Statistics in chemistry. Editorial, *Chemometrics and intelligent Laboratory Systems* 3 (1988) 249-250.

". . . There are at least two areas of chemical research where (access to) good chemometric training will be essential in the future. First, chemists are more than ever using instruments . . . that give rise to enormous amounts of data, usually multivariate. Second, chemistry's interface with medical research, biological research, etc. has led to the study of complicated systems; experiments need to be well-planned and good predictive models may be stochastic.

". . . Chemometrics has already generated statistical applications that encompass experimental design and optimization, calibration, multivariate data analysis and pattern recognition, sampling strategies, and signal processing. New statistical theory and methods are waiting to be developed in response to substantive questions in chemistry. . . ."

—Noel Cressie, from "Statistics in Chemistry"—editorial in *Chemometrics and Intelligent Laboratory Systems,* 3 (1988) 249-250

GROENEVELD, Richard A. Published problem solution: "Matching Socks," Problem E3148. *The American Mathematical Monthly* 95:4 (1988) 357.

MARASINGHE, Mervyn G. *SAS System for Linear Models* (1986 ed.), by R. Freund, R. Littell, and

P. Spector. Cary, NC: SAS Institute, Inc., 1986, x + 210 pp., $14.95. Reviewed in *Technometrics* 30:1 (1988) 116-117.

POLLAK, Edward. *The Neutral Theory of Molecular Evolution.* Motoo Kimura. Cambridge, U.K.: Cambridge University Press, 1983. xv + 367 pp. $69.50 (cloth); $19.95 (paper). Reviewed in *Journal of the American Statistical Association* 82:397 (1987) 365.

SUKHATME, Shashikala. *Nonparametric Statistical Inference* (2nd edition). Jean Dickinson Gibbons. New York: Marcel Dekker, 1985. xv + 408 pp. $34.50. Reviewed in *Journal of the American Statistical Association* 82:399 (1987) 953.

Thesis Abstracts

Eltinge, John Lamont. Measurement error models for time series. Ph.D. thesis, Iowa State University Library. December 1987.

Estimation for multivariate linear measurement error models with serially correlated observations is addressed.

The asymptotic properties of some standard linear errors-in-variables regression parameter estimators are developed under an ultrastructural model in which the random components of the model follow a linear process. Under the same assumptions, the asymptotic properties of weighted method-of-moments estimators are derived. The large-sample results rest on the asymptotic properties of the sum of a linear function and a quadratic function of a sequence of serially correlated random vectors.

Maximum likelihood estimation for the normal structural and functional models is addressed. For each model, first- and second-derivative matrices of the log-likelihood functions are given and Newton-Raphson maximum likelihood estimation procedures are considered. For the structural model, the assumption that the random components follow a multivariate autoregressive moving average process is used to develop autoregressive moving average and state-space models for the observation sequence. The state-space representation of the structural model leads to innovation sequences and associated derivative sequences that provide the basis for a Newton-Raphson procedure for the estimation of regression parameters and autocovariance parameters of the structural model. A modified state-space approach leads to a similar procedure for the estimation for the functional model. An extension of the state-space approach to maximum likelihood estimation for a structural model with combined time series and cross-sectional data is given.

Francisco, Carol Ann. Estimation of quantiles and the interquartile range in complex surveys. Ph.D. thesis, Iowa State University Library. August 1987.

An estimator of the population distribution function that can be used with the complex sampling designs found in survey sampling is given. This estimator is used to define a quantile estimator and an estimator of the interquartile range that are based on the survey design. A design-consistent superpopulation model is assumed, and large sample properties of estimators constructed from single-stage stratified cluster samples are presented. Extensions to other complex designs are discussed. Based on those results, large-sample procedures for constructing confidence sets for quantiles and the interquartile range are given. Design-based variance estimators for both the quantile estimator and the interquartile range are derived from these procedures.

The proposed estimation procedures have been incorporated into PC CARP, a computer program that analyzes data from one-stage or two-stage stratified cluster samples. Computational procedures used to estimate the distribution function, quantiles, the interquartile range, and other associated statistics are briefly described.

Three Monte Carlo simulation studies were performed to evaluate the performance of this implementation of the proposed estimation procedures. For the populations and sample sizes included in the studies, sample quantiles of order 0.25, 0.50, and 0.75 displayed near zero bias. Comparison of observed variances of the quantile estimators to the average of variance estimators across simulated samples showed that the proposed variance estimator is acceptable. In all cases, the obtained coverage probabilities for confidence intervals were near the nominal level of 95 percent.

Hasabelnaby, Nancy Ann Eyink. The use of a weighting function in measurement error regression. Ph.D. thesis, Iowa State University Library. December 1987.

The measurement error model with heterogeneous error variances is considered. Theory for estimators constructed with weighting functions is developed for the case where there is an error in the regression equation and for the case when the equation in the unknown true values is exact. The limiting distribution of the properly standardized weighted estimators is shown to be that of a standard multivariate normal random variable. The limit is taken as the error variances become small and the sample size becomes large.

The specific case where the weighting function is the inverse of a variance function that depends on the true but unknown values of the independent variable is examined. Both linear and nonlinear variance functions are examined.

An example is presented in which there are nonhomogeneous measurement error variances that increase with the value of the independent variable. The variances of the error variances are expressed as a nonlinear function of the true values of the independent variable. Weights based on this function are used to construct estimators of the parameters of the model.

Monte Carlo studies using data similar to that of the example are employed to assess the adequacy of the asymptotic approximations in small samples. In

this example the error variance is about eight percent of the total variance of the explanatory variable. Weighting improves the estimators in samples of 50 observations, but the Studentized statistics require larger samples in order for the distribution to approximate well that of Student's t for the type of data used.

A computer program for weighting the observed values by estimated variances is described. The program is equipped to handle data from complex surveys and to estimate the parameters for models with and without an error in the equation. The program is also capable of outputting the estimated true values and standardized residuals.

Lee, Mong-Hong. Strongly consistent modified maximum likelihood estimation of U-shaped hazard functions. Ph.D. thesis, Iowa State University Library. August 1987.

A hazard function that initially decreases, then drops down to an essentially constant level, and then increases due to aging, often is described as being "U-shaped" or "bathtub-shaped." For such a hazard function $h(\cdot)$, the model interval M is defined as $M = \{m|h(m) = \inf h(x)\}$, which is an interval over which the hazard rate is constant.

T. A. Bray et al. [*Mathematical Note No. 534,* Mathematics Research Laboratory, Boeing Scientific Research Laboratories (1967)] developed the maximum likelihood estimate $\hat{h}(\cdot)$ of a U-shaped hazard function $h(\cdot)$, with $\hat{h}(\cdot)$ certain to equal zero over some open interval, and showed that, if $h(\cdot)$ is "V-shaped," then $\hat{h}(\cdot)$ is strongly consistent at all continuity points of $h(\cdot)$, excepting the "turning point" (i.e., minimizing point, of a "V-shaped" $h(\cdot)$).

Let $\alpha(n)$ be such that both $\alpha(n)$ and $n/\alpha(n)$ tend to infinity with n. This dissertation presents a maximum likelihood estimate $\bar{h}(\cdot)$ of $h(\cdot)$ that is restricted to attain its minimum value at at least $\alpha(n)$ consecutive observations. This estimator $\bar{h}(\cdot)$ everywhere exceeds zero, and is strongly consistent at the continuity points of $h(\cdot)$. While Bray et al. (1967) make use of the well-known "Pooled-Adjacent-Violators" algorithm named by R. E. Barlow et al. [*Statistical Inference under Order Restrictions: The Theory and Application of Isotonic Regression,* John Wiley and Sons, New York (1972)] for monotone estimation, which involves successive revisions at neighboring observation pairs, the algorithm computation of $\bar{h}(\cdot)$ proceeds by successive revisions at neighboring observation triplicates.

Lin, Tsung-Hua Thomas. Confidence sets for the ratio of variance components in a mixed linear model with two variance components. Ph.D. thesis, Iowa State University Library. December 1987.

For an $n \times 1$ observable random vector $\mathbf{y}$, consider the mixed linear model $\mathbf{y} = \mathbf{X}\alpha + \mathbf{Z}\beta + \mathbf{e}$, where $\mathbf{X}$ is an $n \times$ a constant matrix, $\mathbf{Z}$ an $n \times b$ constant matrix, α an $a \times 1$ unknown fixed vector, β a $b \times 1$ unobservable random vector, and $\mathbf{e}$ an $n \times 1$ unobservable random vector. It is assumed that $\beta \sim \mathbf{MVN}[\mathbf{O},\sigma_\beta^2\mathbf{I}]$, $\mathbf{e} \sim \mathbf{MVN}[\mathbf{O},\sigma_e^2\mathbf{I}]$, and β and $\mathbf{e}$ are statistically independent. In many applications, it is of interest to construct a confidence set for $\lambda = \sigma_\beta^2/\sigma_e^2$.

Various tests of the null hypothesis H_0: $\lambda = \lambda_0$ are discussed, including the most powerful translation and scale invariant test (against a specified alternative), the locally most powerful translation and scale invariant test, and the likelihood ratio translation and scale invariant test. Corresponding to each family of tests is a confidence set for λ. The properties of these tests and confidence sets are discussed and are compared with those of Wald's test and confidence set. The computation of the critical points and power functions of the various tests is considered.

Numerical comparisons of the performance of various confidence sets (in terms of probability of a false coverage) are presented for each of five data patterns. Wald's procedure for obtaining a lower confidence bound is very satisfactory when the true value of the parameter is large. The confidence sets corresponding to various families of most powerful invariant tests performed well under a variety of circumstances.

de Morel, Grecia Fernandez. Measures of association for tables of frequencies obtained from cluster sampling. M.S. thesis, Iowa State University Library. August 1987.

A general method is presented for finding asymptotic variances for measures of association for data classified into two-dimensional contingency tables. Formulas for asymptotic variances are well-known for multinomial samples, but these formulas can be quite inaccurate when other sampling schemes are used, even when the total sample size is large. In particular, variances can be much larger for two-stage cluster samples than for simple random samples. The general method presented here can be used for any sampling scheme that provides a consistent estimator of the covariance of the proportions in the two-dimensional contingency table as the total sample size increases.

Details are provided for five particular cases: (1) multinomial sampling from a single population, (2) two-stage cluster sampling from a single population, (3) independent multinomial samples from different populations (or strata) with the populations corresponding to the rows of the two-dimensional table, (4) independent two-stage cluster samples from different populations, and (5) two-stage cluster sampling where independent multinomial samples (or experiments) are performed within each cluster.

Several estimators for covariance matrices of vectors of proportions are presented for the cases involving cluster sampling. In the simplest case, which assumes the true vectors of proportions are distributed across clusters with a Dirichlet distribution, the asymptotic variances of the measures of association are simple multiples of the corresponding asymptotic variances for multinomial samples. Several examples are presented to illustrate how the amount of variation among clusters affects the formulas for the asymptotic variances.

Morel, Jorge G. Multivariate nonlinear models for vectors of proportions: A generalized least squares approach. Ph.D. thesis, Iowa State University Library. August 1987.

A general model is presented for analyzing samples of vectors of proportions whose expectations are smooth functions of a finite set of covariates. The expectations may be nonlinear. The distributions of the observed vectors of proportions are not necessarily multinomial but the models specify the form of the first two moments. These models can be viewed as generalizations of logit models that allow for variation and correlations among sample proportions that are different from those associated with independent multinomial samples.

Regularity conditions are established for the strong consistency and asymptotic normality of a minimum distance estimator of the model parameters. An associated one-step-Gauss-Newton estimator is also investigated. Several specific versions of the general model are given more detailed consideration.

Finite sample properties of the estimation procedures are investigated with a Monte Carlo study. Nominal levels for chi-square tests of the expectation model parameters, the properties of the estimated extra parameters, and the biases of the estimators are examined. Data generated under two different sampling schemes, the logistic multinomial and the logistic multinomial with extra variation, are used in the Monte Carlo study. Example applications are given.

Tirol, Miriam Bridget. Computational aspects and statistical applications of the transportation problem of linear programming. Ph.D. thesis, Iowa State University Library. August 1987.

A special type of linear programming problem that arises quite frequently in practical application is the transportation problem. The transportation problem involves determining a shipping schedule that minimizes the total cost of shipment, given that there are known fixed quantities of a commodity available for shipment at each origin, there are given quantities of a commodity required to be shipped at each destination, and the total shipments from all origins equal the total requirements of all destinations. It is assumed that the minimum cost of shipping a unit of commodity from any origin to any destination is known, and total shipping cost is obtained by taking the sum of individual cost.

The algorithm used for finding an optimal solution requires that an initial basic feasible solution must first be determined. The algorithm improves this solution at each iteration, resulting in a total shipping cost that is less than or equal to the total cost in the previous iteration, until an optimal solution is found. There are different procedures for determining an initial feasible basis. Each of these procedures can give a different initial feasible basis that corresponds to varying total costs, and also takes varying amounts of computational time in obtaining an initial feasible basis. A comparison of the various start procedures was conducted to determine the procedure that would give the best initial feasible basis, that is, one that is close to the optimum and does not use up a lot of CPU time in finding a feasible solution. As a result of this study, it was determined that for large rectangular transportation problems the Large Amount Low Cost method would give the best initial feasible basis, and for square and not very rectangular problems the Modified Minimum Row is best.

The methods for solving transportation problems can be applied to solve some statistical problems. Two statistical problems that can be expressed in the form of a transportation problem are presented, namely, obtaining least absolute value estimates for the two-way classification model and the problem of controlled rounding. The application of the simple upper bounds procedure to obtain optimal solutions for these two problems is demonstrated through numerical examples.

Bill Marion's barbecued chicken: a highlight of the annual fall picnic. Bud Meador dons white gloves to act as assistant while master chef Marion wields the tongs.

Department of Statistics

The Department of Statistics offers courses leading to the degrees Bachelor of Science, Master of Science, and Doctor of Philosophy with major in statistics. These degrees are conferred by the College of Sciences and Humanities and by the Graduate College. A Master of Science degree in operations research is offered jointly with the Department of Industrial Engineering. The Department of Statistics also administers the undergraduate curriculum in biometry leading to a B.S. degree conferred by the College of Agriculture.

Undergraduates in statistics or biometry may choose co-majors if they wish. M.S. candidates may choose either the thesis or the nonthesis option. The latter requires completion of additional credits, including a creative component representing at least two credits of independent work. At the graduate level, joint majors are not frequent choices but do offer a way to add depth in areas of application. More information is given in the departmental brochure, "Iowa State University—Graduate Program in Statistics, August 1988," which is available upon request.

In 1987-88 several changes in the teaching program reflect the department's increasing involvement with industrial and engineering statistics.

During the fall Scott Vander Wiel, working under Steve Vardeman's supervision and with the support of a Graduate College high technology teaching assistantship, developed overhead transparencies for an experimental course, Stat 333x, Probability and Statistics for Electrical and Computer Engineers. This is an accelerated introduction to applied probability and statistical methods with applications in reliability and quality control. The course was developed in response to a request from the Department of Electrical Engineering. It reflects the emphases of short courses that Vardeman presented to Rockwell-Collins reliability and maintainability engineers in August and September 1986.

Also in the fall, Krishna Athreya's lectures for Stat 542, Theory of Probability and Statistics, were televised so that the course could be offered by videotape to staff at Rockwell-Collins in Cedar Rapids, Iowa. This presentation was arranged through ISU Engineering Extension.

Todd Melander taught a section of Stat 227, Introduction to Business Statistics, off campus in the spring. Classes were held at Winnebago Industries in Forest City, Iowa.

Discussions with the Department of Mechanical Engineering led to an ME decision to begin requiring Stat 305 of its majors, beginning fall 1989.

In 1987-88 progress was made on enlarging the pool of computers and software available for graduate student use. By late February four 386/387 based machines had been acquired, intended solely for student use—two Zenith Z-386s and two IBM PS/2 model 80s. In the Statistical Laboratory and Department of Statistics there were at that time approximately 40 CRT terminals used to access the NAS 9160 mainframe computer and VAX cluster computers in the university Computation Center. The VAX cluster provides interactive support for classes and research. In Snedecor Hall we also have approximately 30 IBM-compatible microcomputers. Some of these are used by the clerical staff for document preparation. Others are housed in various sections of the laboratory and are used in research and service activities. A large fraction of the terminals and microcomputers are available to the graduate students for use in their research.

The university-owned AT&T voice/data communication system network provides campus-wide data communications capabilities. Through the Computation Center NAS machine we have access to worldwide digital networks including the very popular BITNET. Access to super-computer support, such as the CRAY machine sponsored by NSF at the University of Illinois, is also arranged through the Computation Center.

Course offerings for the 1987-88 academic year and the 1988 summer session are listed below.

1987-88 Course Offerings in Statistics

Courses for Undergraduate Students Only

100	Orientation in Statistics and Biometry	R	F	Stephenson
101	Principles of Statistics	4	F,S,SS Beam Croos Long	 Mundfrom M. Shelley Stephenson
104	Introduction to Statistics	3	F,S,SS Biele C. P. Cox Grau	 Hotchkiss Long Sukhatme
105	Introduction to Statistics	2	F,S Isaacson Nanayakkara	 Vardeman
201	Regression Analysis for Business	2	F	Nanayakkara
227	Introduction to Business Statistics	5	F,S,SS Graf McDonald Melander Moy Nanayakkara Nelson	 Payton Roesler Schroeder Takle Teasley Wettstein
227x	Introduction to Business Statistics	5	S	Melander
231	Probability and Statistical Inference for Engineers	4	F,S Croos Homblé	 Meeden Sukhatme

305	Engineering Statistics	3	S	Vardeman
328	Applied Business Statistics	3	F,S Groeneveld	Meeker
333x	Probability and Statistics for Electrical and Computer Engineers	3	S	Vander Wiel
341	Introduction to Theory of Probability and Statistics	3	F,S Groeneveld	Pollak
342	Introduction to Theory of Probability and Statistics	3	S	Stephenson

Courses for Graduate Minors and Undergraduates

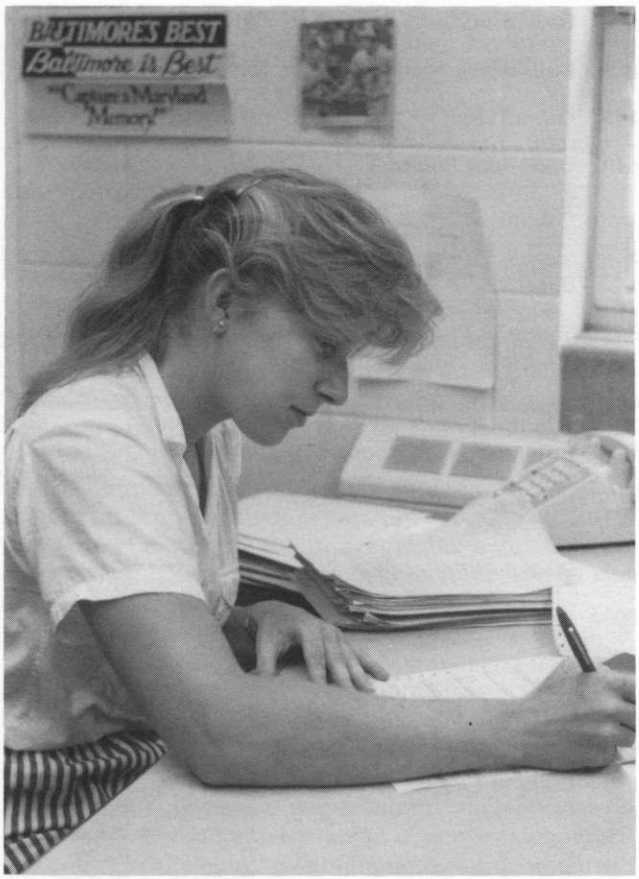
401	Statistical Methods for Research Workers	4	F,S,SS Bailey Beam C. P. Cox D. F. Cox Hickman Hotchkiss	Kennedy McGovern Roberts Shelley Stephenson Strahan
402	Statistical Design and the Analysis of Experiments	3	F,S Hinz & D. F. Cox Hotchkiss	Marasinghe Wolins
404	Statistics for the Social Sciences	3	F	Roberts
405	Applied Econometric Statistics	3	S	Hickman
407	Methods of Multivariate Analysis	2	F	Koehler
421	Survey Sampling Techniques	3	S	Haslett
432	Applied Probability	3	F	Groeneveld
436	Genetic Statistics for Research Workers	3	F	Bailey
447	Statistical Theory for Research Workers	4	S,SS	Amemiya Eltinge
451	Applied Time Series	3	S	Meeker
480	Statistical Application of Digital Computers	3	F	Marasinghe
481	Computer Processing of Statistical Data	3	S	Marasinghe
490	Independent Study	Var	F	Meeker

Courses Primarily for Graduate Students, Major or Minor

500	Statistical Methods	4	F	Hinz
501	Multivariate Statistical Methods	3	S	Koehler
511	Theory and Application of Linear Models	3	S	Amemiya
512	Design of Experiments	3	F	Kempthorne & Hinz
533	Reliability	3	S	Meeker & H. T. David
536	Genetic Statistics	2	F	Pollak
537	Genetic Statistics	2	S	Pollak
538	Econometric Statistics	3	F	Eltinge
539	Game Theory	3	F	H. T. David
540	Operations Research Methods and Economic Analysis	3	S	Sposito
542	Theory of Probability and Statistics	3	F	Athreya
543	Theory of Probability and Statistics	3	S	H. A. David
544	Bayesian Decision Theory	3	SS	Meeden
579	Introduction to Computer Hardware and Software Systems for Statistical Computing	1	F	Kennedy & Marasinghe
580	Statistical Computing	3	F	Kennedy
590A	Special Topics: Theory	Arr	SS	Sposito
590B	Special Topics: Methods	Arr	F	Koehler
590D	Special Topics: Survey Design	2	F	Sukhatme
599	Creative Component	Var	F,S,SS Athreya H. A. David H. T. David Hickman Hinz Koehler Lorenz	Meeker Pollak Sacks Sposito Stephenson Vardeman Wolins

Courses for Graduate Students, Major or Minor

601	Advanced Statistical Methods	3	F	C. P. Cox
606	Spatial Statistics	3	S	Cressie
611	Advanced Linear Model Theory	3	F	Harville
612	Advanced Design of Experiments	3	S	Kempthorne
642	Measure Theory and Probability	3	S	Athreya
643	Theory of Estimation and Testing of Hypotheses	3	F	Meeden
645	Order Statistics	3	F	H. A. David
647	Multivariate Analysis	3	F	Amemiya
651	Time Series	3	S	Fuller
680	Advanced Statistical Computing	3	S	Kennedy
699	Research	Var	F,S,SS Athreya Cressie H. A. David H. T. David Fuller Harville Isaacson	Kennedy Koehler Meeden Meeker Stephenson Sukhatme Vardeman



Jill Roesler is the first recipient of a Graduate College Teaching Excellence Award in statistics at Iowa State.

Graduate Students

A Graduate College Research Excellence Award was given to John Eltinge at commencement in December. This award recognizes research accomplishments demonstrated by completion of an outstanding dissertation. For the first time Graduate College Teaching Excellence Awards were given at Iowa State University. The Department of Statistics recipients were Jill Roesler, in December, and Nuwan Nanayakkara and Teresa Nelson, in May. These awards include a letter of commendation from President Eaton, a certificate of achievement, and a check.

Todd Sanger was awarded a National Science Foundation graduate fellowship providing support for three years.

A larger number of students than usual accepted internships or trainee positions in industry for summer 1988. Todd Sanger, Mary Sayler, and Peter Peterka went to Dow Chemical. Fred Hulting and Carol Meeter joined Procter & Gamble in Cincinnati, Ohio, for the summer. Ann Weltevreden went with Upjohn in Kalamazoo, Michigan. Scott Vander Wiel joined General Electric in Schenectady, New York. Jae McKeown began a six-month internship at PMI. Stephen Rathbun went to Louisiana State University to work as an ecological statistics research assistant in the Department of Botany for three months. The ISU Statistical Laboratory-Weyerhaeuser cooperative internship was awarded to Robert Parker for fall 1987 and summer 1988.

Seven Ph.D. degrees and 24 M.S. degrees were granted in the Department of Statistics during the fiscal year. All but one of the masters' degrees were conferred on a nonthesis basis, with candidates completing creative components based on independent study. Abstracts of Ph.D. dissertations and the M.S. thesis appear in the Publications Section.

Names of graduate degree recipients, with names of major professors, time of graduation, and employment or educational decisions, are given below. An asterisk signifies that the student has chosen to remain at Iowa State to work toward a doctorate in statistics.

M.S. Recipients

Douglas Alan Bearrood (Spring 1988; Roy Hickman) accepted a position as quality assurance representative with Rosemount Engineering in Eden Prairie, Minnesota.

***Victor Pedro Brescia** (Fall 1987; Paul N. Hinz) is working toward a joint Ph.D. degree in economics and statistics at Iowa State.

Keng-tang Chien (Fall 1987; Herbert T. David) is working toward a Ph.D. degree in economics at Iowa State.

Clarice Janelle Dombek (Fall 1987; William Q. Meeker, Jr.) joined Dow Chemical Company, Midland, Michigan, in September 1987 as a statistical analyst in its Mathematics Applications Group, Information and Communication Services Department.

***Clarice Azevedo de Luna Freire** (Spring 1988; Kenneth J. Koehler).

Jooi-Tow Goh (Spring 1988; Kenneth J. Koehler) joined her husband, John Edwards, in Rochester, Minnesota.

Eric Anderson Grau (Spring 1988; Frederick Lorenz) has been working as a statistician for Citicorp POS Information Bureau in Stamford, Connecticut.

***Martin Oscar Grondona** (Fall 1987; Noel A. C. Cressie).

***Geun-Shik Han** (Spring 1988; Kenneth J. Koehler).

Zhaofeng Huang (Summer 1987; Yasuo Amemiya) is working as a reliability engineer at Rockwell International in Canoga Park, California.

Jane Marie Johnson (Summer 1987; Jerome Sacks) is a marketing analyst for Fingerhut Corporation, Minnetonka, Minnesota.

***Jingyu Liu** (Spring 1988; H. A. David).

Shwu-Fen Liu (Spring 1988; Vincent A. Sposito) is a member of the Technical Staff of GTE Laboratories, Inc., Waltham, Massachusetts, working as a statistical consultant.

Grecia Maria Fernandez de Morel (Summer 1987; Kenneth J. Koehler) moved to Tampa, Florida, with her husband Jorge (see Ph.D. list below) and son David.

Terry Moy (Spring 1988; William Q. Meeker, Jr.) joined Process Management Institute, Bloomington, Minnesota, as a statistical consultant on its Client Services Team.

Teresa Ann Nelson (Spring 1988; Paul N. Hinz) accepted a position as market analyst with Fingerhut in Minnetonka, Minnesota.

***Sarah Margaret Nusser** (Fall 1987; Paul N. Hinz).

***Stephen Lynn Rathbun** (Summer 1987; Noel A. C. Cressie).

Jill Lynn Roesler (Summer 1987; Frederick O. Lorenz) joined the Marketing Research Division of A. C. Nielsen Company, Northbrook, Illinois, as senior research statistician.

Shiowlin Su (Summer 1987; Vincent A. Sposito) is working toward a master's degree in business administrative sciences at Iowa State.

***Scott Alan Vander Wiel** (Summer 1987; William Q. Meeker, Jr.).

***Kui-Jang William Wang** (Fall 1987; H. A. David).

Shaw-Ling Wang, Chu (Summer 1987; Mark Reiser) began work on July 1, 1987, as assistant biotech/plant breeding statistician for Garst Seed Company, Slater, Iowa.

Susan Eileen White (Fall 1987; Jerome Sacks) is a research associate in agronomy at Iowa State University.

Ph.D. Recipients

John Lamont Eltinge (Fall 1987; Wayne A. Fuller) is an assistant professor of statistics, teaching and engaged in research in the ISU Statistical Laboratory's Survey Section.

Carol Ann Francisco (Summer 1987; Wayne A. Fuller) is continuing to work at Syntex Laboratories, Inc., Palo Alto, California, as biostatistician in Medical Affairs.

Nancy Ann Eyink Hasabelnaby (Fall 1987; Wayne A. Fuller) remained at Iowa State as a postdoctoral research associate in the Statistical Laboratory Survey Section.

Mong-Hong Lee (Summer 1987; Herbert T. David) is on the faculty of the Department of Applied Mathematics, Sun Yat Sen University, Kaoshung, Taiwan, as an associate professor.

Tsung-Hua Thomas Lin (Fall 1987; David A. Harville) joined Upjohn Company, Kalamazoo, Michigan, as medical biostatistician in October 1987.

Jorge Guillermo Morel (Summer 1987; Kenneth J. Koehler and Wayne A. Fuller) is an assistant professor in the Department of Epidemiology and Biostatistics, College of Public Health, University of South Florida.

Miriam Bridget Tirol (Summer 1987 in industrial engineering and statistics; Vincent A. Sposito and Way Kuo) accepted a visiting assistant professorship in the Department of Statistics and Actuarial Science, University of Iowa, for the 1987-88 year.

M.S. Candidates

Agatep, Maria Theresa
Bearrood, Douglas
Brand, Linda M.
Brown, Kimberly
Castrogiovanni, Carl
Chen, Chao-Yin
Chen, Ching-Ju Diane
Chen, Shih-Neng
Chen, Shou-Wei
Chien, Keng-tang
Chisolm, Barbara A.
Chiu, Jia-Chyi
Cho, Tae-Kyoung
Coffin, Marie A.
Cormack, Jean
Cutler, Sheri L.
Dombek, C. Janelle
Fagih, Abdullah Y.A.K.
Fredolin Tangang @ Tajudin Mahmud
Garrigoux, Christian
Gau, Shiow-Lan
Goh, Jooi-Tow
Graf, Deanna L.
Grau, Eric A.
Griffiths, Richard
Halvorson, Joel D.
Hoveland, Amy
Huang, Mu-Yeh
Huang, Zhaofeng
Iversen, Philip W.
Johnson, Jane M.
Kuo, Bojein
Lay, Alice S.
Lee, Kyung-Hee Ghang
Lee, Ming-Yu
Lee, Yung-Seop
Liou, Ge-Shean Albert
Liu, I-Ming
Liu, Shwu-Fen
Long, Cynthia
McKeown, Jae P.
Meeter, Carol A.
Melander, Todd E.
Misambo, Barnabas M.
Morel, Grecia
Moy, Terry
Murphy, Dennis J.
Navvabpour, Hamid R.
Nelson, Teresa A.
Nininahazwe, Yvon
Park, Kwan Soo
Payton, Kathrina E.
Peterka, Peter
Poggemann, Anne M.
Prins, Dawn E.
Remadi, Sellem
Sabran, Muhamad
Salihima, Astini
Sanger, Todd M.
Sayler, Mary E.
Schroeder, Darrell
Shamsuddin, Hussein
Shyu, Chii-Jyh
Steenhard, David
Suharno
Swanson, Wendy
Takle, Teresa A.
Talib, Ibrahim O. A.
Teasley, Brian
Tiro, Muhammad A.
Vasconcelos, M. Katheleen
Wall, Steven J.
Weltevreden, Ann
Wettstein, Susan A.
White, Susan E.
Yang, Ching-Ching
Yansaneh, Ibrahim S.
Yen, Shu-Yuan
Yu, Yunn-Hwu

Ph.D. Candidates

Adam, Abdoulaye
Al-Mahmoud, Ahmad M. A.
Andrews, Douglas M.
Beam, Craig A.
Biele, Jonathan
Brescia, Victor P. (joint statistics-economics)
Bryan, Mark F.
Carley, Michael R. (joint statistics-economics)
Carriquiry, Alicia (joint animal science-statistics)
Cranford, B. Keith
Croos, Joseph H. R.
Davis, Paula Lasack (joint entomology-statistics)
Eltinge, John L.
Freire, Clarice
Fuh, Cheng-Der (joint mathematics-statistics)
Funo, Eiichiro
Gotway, Carol A.
Grondona, Martin O.
Guo, Renkuan
Han, Geun-Shik
Hasabelnaby, Nancy Eyink
Homblé, Patrick R.
Hong, Chong Sun
Hulting, Frederick
Jensen, Karen
Kang, Yoou-Jen
Kim, Song-Ho
Lee, Mong-Hong
Lemke, Klaus (joint statistics-economics)
Li, Seung-Chun
Lin, Chiou-Hua
Lin, Tsung-Hua Thomas
Liu, Jingyu
Lu, Chi-hsien Joseph
Masoud, Sami M. A.
McDonald, David G.
Medak, Frederick M.
Mingoti, Sueli A.
Morel, Jorge G.
Mundfrom, Daniel J.
Nanayakkara, Nuwan
Nusser, Sarah M.
Park, Heon Jin
Rathbun, Steven L.
Roesler, Jill L.
Sarkar, Sahadeb
Sriplung, Kai-One (joint economics-statistics)
Sullivan, Gary R.
Sung, Nae Kyung
Symanowski, James T.
Tirol, M. Bridget (joint industrial engineering-statistics)
Tollefson, Margot H.
Vander Wiel, Scott
Ver Hoef, Jay (joint botany-statistics)
Wang, Chung-Ching Morgan
Wang, Kui-Jang William
Zakaria, Rahmat S. (joint statistics-industrial engineering)
Zimmermann, Alan

Snedecor and Bancroft Awards

Three outstanding students were presented the 1988 George W. Snedecor Award this year as the most outstanding Ph.D. candidates in the Department of Statistics. The award is open to all Ph.D. or joint Ph.D. students who have completed a preliminary examination in statistics during the preceding calendar year. It honors the founder and first director of the Statistical Laboratory. Recipients were Carol Gotway, Frederick Hulting, and Heon Jin Park.

Gotway graduated from Bradley University magna cum laude with B.S. degrees in mathematics and geological science. Hulting's B.S. program was in

statistics/computer science, with honors, at the University of California—Davis. Park's B.S. degree in computer science and statistics was granted by Seoul National University. All three students obtained M.S. degrees in statistics at Iowa State and have graduate appointments. Gotway interned with RAND Corporation summer 1987; Hulting was a 6-month statistical intern with Weyerhaeuser Company in 1985 and is a 1988 summer intern with Procter & Gamble.

The 1988 T. A. Bancroft Award was presented to Paula Lasack Davis, a Ph.D. student with co-majors in entomology and statistics. This award, granted for the first time for the year 1972, is designed to encourage study of the application of statistics to a substantive area. It recognizes achievements in statistics of doctoral students who have completed prelim examinations in the past calendar year and either have a joint major in statistics and some other area or have declared a minor in statistics. The award honors Theodore A. Bancroft, who was director of the Statistical Laboratory and head of the Department of Statistics from 1950 to 1972.

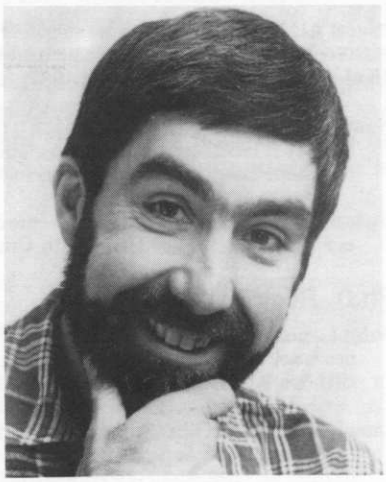
Davis received her B.S. (honors) degree in biometry and pest management at ISU in 1981 with distinction, then worked for Crop Pro-Tech, Inc., a crop scouting firm in Naperville, Illinois, for nearly three years. She returned to ISU to complete an M.S. degree in entomology in 1986, including research focusing on an intensive sampling study of natural populations of stalk borers, major pests of corn. With information obtained in her doctoral study, she hopes to construct a practical computer simulation model for use in future stalk borer management programs. She received Entomology Society of America-North Central Branch student research awards in 1986 and 1988 and is author of a number of journal publications and technical reports.

B. V. Sukhatme Memorial Lecture

The 6th B. V. Sukhatme Memorial Lecture was presented by Janet L. Norwood on October 14, 1987. She spoke on the topic "A Statistical View of the Economy." Dr. Norwood has been commissioner of labor statistics in the U.S. Bureau of Labor Statistics, Washington, D.C., since 1979. Her major fields of statistical activity have been the survey and analysis of employment and unemployment, and price, wage, and productivity surveys and analyses. The Sukhatme lecture series honors the late Bal Sukhatme, professor of statistics at ISU from 1968 to 1979, who attained wide recognition for his work in survey sampling.

Dr. Norwood became president-elect of the American Statistical Association in January 1988. She is a fellow of the American Statistical Association and the American Association for the Advancement of Science, a member of the International Statistical Institute, and a recipient of the National Academy of Public Administration's 1984 National Public Service Award and awards from the American Society for Public Administration and the U.S. Department of Labor. She received her doctorate at Tufts University and holds honorary LLD degrees from Florida International University and Carnegie Mellon.

George Zyskind Memorial Lecture



Berkely professor Terence Speed presented this year's Zyskind lecture.

The 13th George Zyskind Memorial Lecture, titled "Three highlights in the history of least squares," was given by Terence P. Speed on November 10, 1987. Formerly chief of the CSIRO Division of Mathematics and Statistics, Canberra, Australia, Speed is now professor of statistics in the University of California-Berkeley. He received his doctorate at Monash University in 1969 and subsequently taught at the University of Sheffield and the University of Western Australia before joining CSIRO. He is a fellow of the Institute of Mathematical Statistics and the Institute of Mathematics and Its Applications and a member of the International Statistical Institute.

Speed is the author of over 80 journal articles. His early work was on various aspects of modern algebra. Then he worked extensively on theory of stochastic processes. In recent years he has devoted much effort to applications of modern algebra—especially combinatoric theory—to ideas on cumulants in statistics, to analysis of variance, and to design and analysis of experiments.

The Zyskind lecture series honors the late George Zyskind, professor of statistics at ISU from 1959 to 1974. This year's lecture was jointly sponsored by the ISU Statistical Laboratory and the Iowa chapter of the American Statistical Association. Dr. Speed also presented a seminar, "On structure, relation, generalized cumulants, and expectations of polynomials," in the regular Statistical Laboratory series on November 11.

Iowa STAT-ers

The graduate statistics club, Iowa STAT-ers, developed new projects and carried on its older activities with gusto under the leadership of Sarah Nusser, president. The newsletter *Iowa STAT-er Chatter* was published for a second year. A reading group was established by Mark Bryan and Sarah

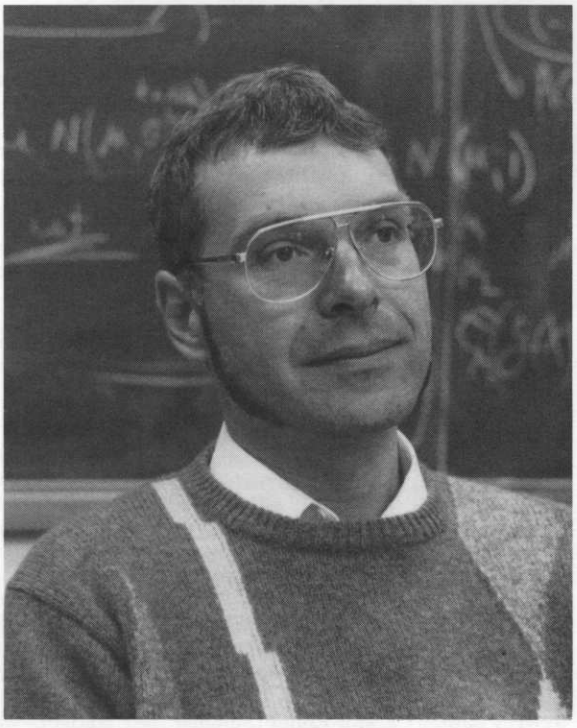
Nusser, with help from Karen Jensen, to broaden participants' exposure to statistical literature and concepts not focused on in coursework. The group held bimonthly discussion meetings. The Iowa STAT-er seminar series, coordinated by Mark Bryan, is described on p. 47.

Two fund-raising efforts were used to supplement club dues to support academic and social activities. ISU statistics t-shirts and an Iowa STAT-er birthday calendar were sold. The calendar was a joint effort by Doug Andrews and Jae McKeown. Social events held during the year and organized by Doug Bearroud and Todd Melander included a Halloween party, a holiday gift exchange, the spring pizza party, and the STAT-ers Winter Party for the combined statistics faculty, staff, and student groups. CPR training was also arranged for interested Iowa STAT-ers.

This year the Iowa STAT-ers also tried to address directly the problem of improving the integration of international and U.S. students. They now have a statistics graduate student senator, Sueli Mingoti, to represent international student interests in ISU student government. Also the first annual cultural party was held for Iowa STAT-ers on April 23, organized by Latin American members and featuring native foods, wall displays on Uruguay and Brazil, slide shows on Argentina and Uruguay, music, and dancing.

Officers for the year were Sarah Nusser, president; Mark Bryan, vice president; Kathy Payton, treasurer; and Anne Poggemann, secretary. Fred Hulting was the student representative at statistics faculty meetings. Kenneth J. Koehler served as faculty adviser to Iowa STAT-ers.

George W. Snedecor Lecture



Australian statistician Peter G. Hall.

The 4th George W. Snedecor Lecture was presented on April 25, 1988, by Peter G. Hall, who spoke on the topic "Edgeworth Expansions and the Bootstrap." He gave a more technical talk on the same subject on April 26 as a regular Statistical Laboratory seminar. The Snedecor Lecture program is a series of occasional lectures that recognize George Snedecor's pioneering contributions to the field of statistics and to the Statistical Laboratory.

Dr. Hall, a member of the Department of Statistics, Australian National University, Canberra, received his Ph.D. degree at Oxford University under John Kingman. He is an important and extraordinarily prolific contributor to the literature of probability and statistics. An associate editor of both *The Annals of Probability* and *The Annals of Statistics,* Hall is also author of *Introduction to the Theory of Coverage Processes* (Wiley, 1988) and a fellow of the Institute of Mathematical Statistics.

Mu Sigma Rho

Mu Sigma Rho lecturer David Moore advocates making statistics part of liberal arts education.

The 17th annual Mu Sigma Rho lecture was presented by David S. Moore, professor of statistics at Purdue University, who spoke on "Statistics Among the Liberal Arts." By adopting the view that the liberal arts should focus on learning to learn, Dr. Moore argued that Statistics, as the "science of reasoning from empirical data," is a fundamental and independent discipline that deserves a place in any liberal education. He also outlined an approach to

teaching statistics to liberal arts students that concentrates on the elements of statistical thinking and avoids "theorem-proof" and "cookbook" styles of teaching. His talk inspired and provoked a great deal of thought and discussion among the more than 100 attendees from various departments.

Moore is currently the statistics content developer for the educational television series *Against All Odds: Inside Statistics,* which is being produced by the Annenberg Foundation/Corporation for Public Broadcasting. His research interests include large sample theory, tests of fit, and density estimation. He has published nearly 40 research papers and is the author of the book *Statistics: Concepts and Controversies.* Moore's visit on April 12-14, 1988, was co-sponsored by the Iowa STAT-ers; the undergraduate Statistics Club; the departments of Statistics, English, Political Science, Economics, Mathematics, Sociology and Anthropology, and Psychology; and the university Committee on Lectures.

Twenty-three new members were initiated into the Iowa Alpha chapter of the honor society at the annual banquet, which preceded the April 12 lecture. The 15 graduate students and 8 undergraduates were recognized for their scholarly achievements in statistics course work. Officers for 1987-88 were Fred Hulting, president; Scott Vander Wiel, vice president; and Mary Anne Dellva, secretary-treasurer. W. Robert Stephenson served as faculty adviser. Officers for the 1988-89 year have not yet been selected.

Undergraduates

Undergraduate majors in statistics received a number of recognitions and awards during the academic year. Barbara Lytle (biometry) and Michael Wall were recognized for being in the top 2 percent of the freshman class in the colleges of Agriculture and Sciences and Humanities, respectively, at the 1988 Scholarship Recognition Dinner on April 25. On the following day Kathy Jenkins and Barbara Worth were recognized for standing in the top 2 percent of the junior class, and Craig Kollman was recognized as the highest-ranked graduating senior in statistics.

At the banquet of the Phi Kappa Phi Honor Society on March 30, Mary Anne Dellva and Scott Kongable were initiated to membership. At the annual banquet of the Mu Sigma Rho statistics honorary on April 12, undergraduates Diane Hamilton, Julie Hunsinger-Wiese, Kathy Jenkins, Julia Klein, Rochelle Milbrath, Bruce Schnicker (biometry), and Michael Stamp were initiated as members. At a ceremony on April 17, Kathy Jenkins and Barbara Worth were initiated to membership in Phi Beta Kappa.

Douglas Jensen, a junior with a joint major in journalism and mass communication and statistics, was chosen as a member of Lampos, the Sciences and Humanities honorary. He also received a Laura Vernon Scholarship.

Mary Ann Dellva took part in the university's Spring 1988 Honors Projects Poster Presentation as a graduating honors program senior. Her project, for which W. Robert Stephenson served as adviser, dealt with "Individuals and moving range control charts: The importance of average run lengths in their design and use."

Mary Ann Dellva with her project at the Honors Projects Poster Presentation.

Fourteen students received B.S. degrees in statistics during the period July 1, 1987 to June 30, 1988; three of these had joint majors. In addition, one student graduated in the B.S. program in biometry. Names of the recipients follow, with employment or study plans, where definite.

Zainudin bin Awang (Summer 1987, statistics) returned to Jelawat, Kelantan, Malaysia.

Mary Anne Dellva (Spring 1988, honors program in statistics, with distinction) is continuing her studies as a graduate student in statistics at Iowa State.

Glenn Louis Des Jardin (Spring 1988, statistics) is a market research supervisor with Project Research, Inc., Minneapolis, Minnesota.

Diane Renee Hamilton (Spring 1988, joint majors in statistics and sociology) accepted a position as statistical analyst at the Garst Seed Company, Slater, Iowa.

Julie Lynn Haubrich (Spring 1988, statistics) is working for Central Life Assurance Company as an actuarial trainee in Des Moines, Iowa.

Bruce Patrick Hughes (Spring 1988, biometry) accepted a position as a mathematical statistician (GS5) in the U.S. Bureau of the Census, Agricultural Division, Washington, D.C.

Julie Hunsinger-Wiese (Spring 1988, statistics) is currently employed by Lincoln National Life Insurance Company as an actuarial assistant in Fort Wayne, Indiana.

Craig R. Kollman (Fall 1987, honors program, joint majors in statistics and mathematics, with distinction) began graduate studies in the Department of Statistics, Purdue University.

Jeffrey James Larson-Keller (Summer 1987, statistics) is a data analyst/statistician with Mayo Clinic, Rochester, Minnesota.

James Gerald Markowski (Spring 1988, statistics).

Michael David Stamp (Spring 1988, joint majors in economics and statistics) is beginning graduate study in statistics at Virginia Polytechnic Institute and State University.

Teresa M. Testroet (Fall 1987, statistics) is continuing study at Iowa State University in mathematics and general education.

Tami Sue Thompson (Summer 1987, statistics) received a commission in the U.S. Air Force Reserve at the ISU Commencement and is stationed as second lieutenant at Goodfellow Air Force Base, San Angelo, Texas.

Steven Lee Wallrichs (Fall 1987, statistics) is a data analyst/statistician with Mayo Clinic.

Ellen Kay Winey (Spring 1988, statistics) took a position with Oak Cable Systems in Huxley, Iowa.

Four continuing undergraduate students have summer positions involving statistics. Kathy Jenkins is working for Pioneer Hi-bred International at Johnston, Iowa; Rochelle Milbrath, at the Mayo Clinic, Rochester, Minnesota; and Thomas Owens and Bruce Schnicker (biometry), at Asgrow Seed Company in Ames, Iowa. Owens' internship will continue through December 1988. Schnicker held a similar summer-fall internship at Asgrow in 1987.

In addition, joint-major Douglas Jensen has a summer position with Clarity, Coverdale & Rueff, a Minneapolis, Minnesota, advertising firm.

Statistics Club

Increased enthusiasm on the part of the undergraduate students interested in statistics made for an exciting year for the Statistics Club. There were many functions—social, academic, and career-oriented—throughout the year. A monthly newsletter was published.

The academic year began with the now traditional STAT CLUB FAC and pizza feed. This informal get-together provides an opportunity for students to catch up with old friends and meet new ones.

The first business meeting focused on the experiences of undergraduates who had statistics-related summer jobs. Craig Kollman, who had worked for A. C. Nielsen the last two summers, talked about the varied projects he worked on. These included computer work to transfer data from Nielsen's data bank and to convert it to a more convenient format, analysis of survey data, and survey design. Kathy Jenkins was part of a program at Iowa State to encourage women's involvement in science and advanced instrumentation. Her project involved work with a computer/imaging instrument used to analyze areas of tissues and cells. Mary Anne Dellva had a summer position with Kimberly/Clark at its regional offices outside Atlanta, Georgia. She worked with data on sales projections to see if they came close to the actual sales (they often didn't).

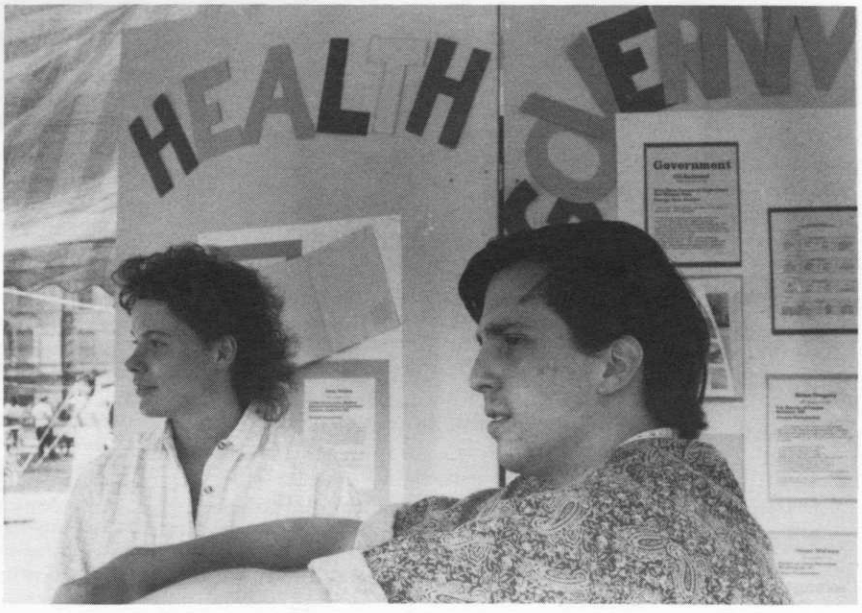
Cathryn Dippo, from the U.S. Bureau of Labor Statistics, Washington, D.C., spoke to the club in November. She discussed career opportunities at BLS and with the federal government in general.

The club geared up for spring semester with an informal gathering in January. There were several meetings during the spring to plan for VEISHEA, the annual university-wide student festival. In March, Duane Skow, state statistician with the National Agricultural Statistics Service (NASS) in Des Moines, Iowa, spoke to the club. He talked about summer and permanent employment with NASS.

The Statistics Club finished the year with the VEISHEA open house display on central campus. This year's display, entitled "We don't do STATS!," illustrated what statisticians do and tried to dispel some popular misconceptions about statisticians. The club greatly appreciated the information provided by former undergraduate statistics majors to help make the 1988 display a success.

Elections were held in May. The 1988-89 officers are:

president: Christine Pieper Lundahl
vice president: Douglas Jensen
treasurer: Joe Surber
secretary: Anita Hinkeldey.



The 1988 Veishea display: Statistics Club president Michael Stamp with Susan Reese, a senior in marketing. Theme of the canopied open-air display on central campus was We Don't Do "Stats" (or accounting or sports facts or weather forecasting). The display focused on what statisticians, at least recent Iowa State graduates, are doing—in industry, government, actuarial science, health-related fields, and graduate school. Stamp, a May graduate, plans to continue studies in statistics.

Kathy Jenkins was chosen as recipient of the 1988-89 Statistics Club Award. W. Robert Stephenson serves as faculty adviser to the club.

■ Seminars

The series of regular weekly noncredit seminars offered by the Statistical Laboratory and the Department of Statistics throughout the 1987-88 year was planned by Herbert T. David, John Eltinge, and Dean Isaacson. The Iowa STAT-ers organized a separate seminar series designed for students not yet involved in research.

Statistical Laboratory Seminars

Summer 1987

July 1 — Computational aspects and statistical applications of the transportation problem of linear programming. M. Bridget Tirol

15 — An applied research comparison of advanced least squares methods. Rolland L. Hardy, Department of Civil Engineering, Iowa State University

22 — Confidence sets for the ratio of variance components in a mixed linear model with two variance components. Tsung-Hua Thomas Lin

August 13 — Robust ridge regression. Mervyn Silvapulle, School of Agriculture, La Trobe University, Melbourne, Australia

Fall 1987

September 2 — A celebration of the Department of Statistics' Fortieth Anniversary. Dean L. Isaacson

9 — On survival probabilities for multitype branching processes. Edward Pollak

16 — Tests for nonadditivity in three-way classifications with one observation per cell. Mervyn G. Marasinghe

23 — Using the 'Polya posterior' in point and set estimation problems in finite population sampling. Glen Meeden

30 — Assessing local influence in regression analysis with censored data. William Q. Meeker, Jr.

October 7 — Experimental design and quality improvement: The Taguchi phenomenon. W. Robert Stephenson

28 — Confessions of a closet statistician, or the stochastic nature of engineering design. Charles R. Mischke, Department of Mechanical Engineering, Iowa State University

November 11 — On structure, relation, generalized cumulants, and expectations of polynomials. Terence P. Speed, Department of Statistics, University of California-Berkeley

18 — Confounding in contingency tables. Gary Glonek, Department of Statistics, University of Chicago

December 2 — The effect of covariance structure on variance estimation in balanced growth curve models with random coefficients. Nicholas T. Lange, Division of Biology and Medicine, Brown University

Spring 1988

January 20 — The use of a weighting function in measurement error regression. Nancy A. Hasabelnaby

27 — Limits in system reliability improvement—Part I: Reliability analysis of k-out-of-n system structure. Way Kuo, Department of Industrial Engineering

February 3 — Controlling a process to a goal in finite time. Ananda Weerasinghe, Department of Mathematics

17 — Survey research on biotechnology and economic development: Some perspectives and preliminary findings. Mack C. Shelley II

24 — Sample survey estimators which are linear in the responses: Design and superpopulation properties for noninformative designs. Stephen J. Haslett

29 — D-optimal blocking of response surface designs. Christopher J. Nachtsheim, Department of Management Sciences, University of Minnesota

March 8 — Computer experiments. William J. Welch, Department of Statistics and Actuarial Science, University of Waterloo

15 — Improved estimation in some nonregular situations. Debapriya Sengupta, Department of Statistics, University of North Carolina, Chapel Hill

17 — Bayesian diagnostics for almost any model. Robert E. Weiss, Department of Applied Statistics, University of Minnesota

21 — A-optimal and highly efficient block designs for comparing test treatments with a control. John Stufken, Department of Statistics, University of Georgia

23 — Estimation of the mean vector of multivariate normal mixtures. William E. Strawderman, Department of Statistics, Rutgers University

April 13 — Power approximations for multinomial tests of fit. David S. Moore, Department of Statistics, Purdue University

20 — A central limit theorem for the sample mean in finite population sampling. Krishna B. Athreya

26 — Edgeworth expansions and the bootstrap. II. Peter G. Hall, Department of Statistics, Australian National University, Canberra

27 — Granularity and efficiency. C. S. Hong

May 4 — Nonparametric combination of dependent tests. Fortunato Pesarin, Department of Statistics, University of Padua, Italy

11 — The decline of Christendom in the Middle Ages. Carl W. Roberts

Summer 1988

June 15 — A class of nonparametric procedures for comparing two survival distributions based on randomly censored data. S. S. Winston Yang, Department of Statistics, Kansas State University

Special Lectures and Seminars

October 12 — Joint Statistical Laboratory and Department of Industrial Engineering Seminar: On a class of production-inventory models. B. Levikson, Department of Statistics, University of Haifa, Technion, Israel

14 — 6th B. V. Sukhatme Memorial Lecture: A statistical view of the economy. Janet L. Norwood, U.S. Bureau of Labor Statistics

21 — Joint College of Engineering and Statistical Laboratory Seminar: NBS in transition: Implications for statistics. Robert Lundegard, National Bureau of Standards

November 4 — Interdisciplinary Seminar in Statistics: Empirical Bayes confidence intervals based on a bootstrap approach. Nan M. Laird, Department of Biostatistics, School of Public Health, Harvard University. [Sponsored by the Iowa STAT-ers, Statistical Laboratory, Department of Mathematics, Department of Animal Science, and Graduate College]

10 — 13th George Zyskind Memorial Lecture: Three highlights in the history of least squares. Terence P. Speed, Department of Statistics, University of California-Berkeley. [Cosponsored by the Iowa chapter of the American Statistical Association]

December 7 — Interdisciplinary Seminar in Statistics: The Japanese and quality control: Another view. Samuel C. Saunders. [Sponsored by the Statistical Laboratory, Iowa STAT-ers, Department of Industrial Engineering, Department of Materials Science and Engineering, Graduate College, and ISU Industry/University Affiliate Program for Productivity, Quality, and Reliability]

April 12 — Mu Sigma Rho Lecture: Statistics among the liberal arts. David S. Moore, Department of Statistics, Purdue University. [Sponsored by Mu Sigma Rho; Iowa STAT-ers; the Statistics Club; departments of Statistics, Political Science, English, Economics, Mathematics, Sociology and Anthropology, and Psychology; ISU Committee on Lectures]

21 — Interdisciplinary Colloquium: Issues in supercomputing and computational science: Remote and local. John W. D. Connolly, Center for Computational Services, University of Kentucky. [Sponsored by the Vice President for Research, Computation Center, and departments of Chemical Engineering, Computer Science, Chemistry, Electrical Engineering and Computer Engineering, Mathematics, Mechanical Engineering, and Statistics]

25 — 4th George W. Snedecor Lecture: Edgeworth expansions and the bootstrap. Peter G. Hall, Department of Statistics, Australian National University, Canberra

May 2 — Interdisciplinary Lecture in Statistics: Confidence curves in nonlinear regression. R. Dennis Cook, Department of Applied Statistics, University of Minnesota. [Sponsored by Iowa STAT-ers, Statistical Laboratory, ISU Center for Agricultural and Rural Development, Department of Mathematics, and Graduate College]

18 — Joint Economics and Statistics Seminar: Alternate approaches to model selection. Alice Nakamura and Masao Nakamura, University of Alberta, Canada.

Iowa STAT-ers Seminar Series

September 14 — The Department of Statistics at Dortmund. Franz Hering, Department of Statistics, University of Dortmund, West Germany

28 — Applications of paired comparisons at Procter & Gamble. Douglas Andrews

October 12 — Applications of dynamic graphical methods. Frederick Hulting

26 — Internships in industry. Todd Melander, Terry Moy, Teresa Nelson, Scott Vander Wiel, and Susan Wettstein

November 4 — See above for Interdisciplinary Seminar in Statistics.

16 — On teaching the concept of a density function of a continuous random variable in an elementary statistics course. George E. Battese

December 7 — See above for Interdisciplinary Seminar in Statistics.

January 22 — Statistics for spatial data. Noel Cressie

February 25 — Statistics for quality, reliability, and competitiveness in the aircraft industry. Kim Erland, Pratt & Whitney Aircraft

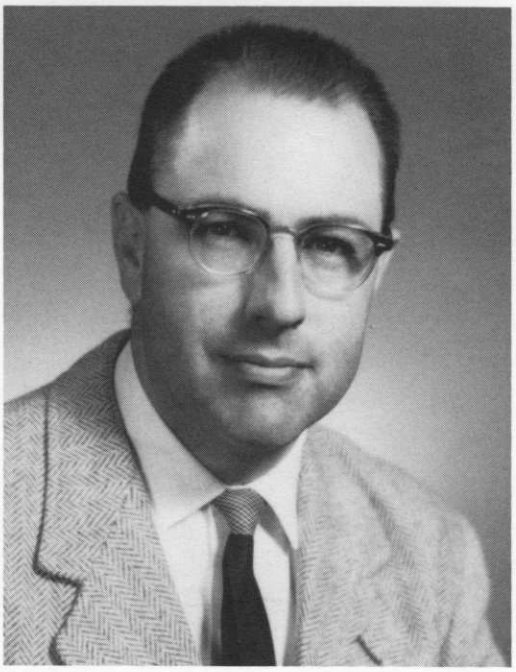
April 1 — Accuracy of approximate confidence intervals for censored Weibull regression data. Scot Vander Wiel

4 — Designing successful lottery games. Edward Stanek, Iowa Lottery Commission

18 — When randomized clinical trials are impractical, what can a statistician do? William Taylor, Mayo Clinic

In Memoriam

Robert Joseph Buehler, 1925-1988



Robert J. Buehler died at home on July 8, 1988. At the time of his death, he was a full professor in the School of Statistics at the University of Minnesota.

Buehler was born May 1, 1925, in Alma, Wisconsin. He completed degree programs for the B.S. in chemistry, M.S. and Ph.D. in mathematics at the University of Wisconsin. From 1951 to 1955 he was a mathematician at Sandia Corporation, Albuquerque, New Mexico, before returning to Wisconsin for over two years to engage in research in the Naval Research Laboratory, Department of Chemistry, and to teach mathematics and statistics.

Buehler joined Iowa State University's Statistical Laboratory and Department of Statistics in 1957 as an assistant professor and was promoted to associate professor in 1960. In 1963 he joined the University of Minnesota as full professor. He served as chair of the Department of Theoretical Statistics 1973-1978. From then until his death he continued teaching and research in the School of Statistics at Minnesota.

Buehler married Barbara Martin (an ISU alum) in 1964 and had three children, David, Theodore, and Kathryn. He was a fellow of the American Statistical Association and the Institute of Mathematical Statistics and a member of the International Statistical Institute. He had worldwide status as a contributor to research on the foundations of statistics. An especially important paper is "Some validity criteria for statistical inferences," *Annals of Mathematical Statistics* 30:3 (1959) 845-863.

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A publication of the Statistical Laboratory
Iowa State University

Editor, Jauvanta M. Walker